The Social Life of Forests

Trees communicate, cooperate and even recognize their kin. Welcome to the wonderful networks of the forest.

By Jason Mark
Photographs by Hannah Gamiz Ko

As a child, Suzanne Simard often roamed Canada's forests with her family. Her parents, who had left the farm fields behind, foraging mushrooms in the huckleberries and occasionally eating handfuls of berries. Her father was a logger who felled ancient, resinfilled, redheart hemlock and Douglas fir, using two-man crosscut saws to saw through their trunks. Simard's mother was a waitress at a local diner. The Kootenay River Valley, where the family lived, was a place of rugged beauty, with rapids and tumbling waterfalls, cedars and hemlocks, and mountains that rose "into the sun" — a place, Simard recalls, perfect as it was. When she began attending the University of British Columbia, she was surprised to learn that the forest she had spent years of her life in was deemed to be "overstocked" with trees. It seemed like the natural choice.

Simard's parents had moved to the Kootenay Valley in the early 1960s, when the Canadian government had commercial clearcutting had largely supersedded the selective logging practiced by her father. The forests were replanted, mostly with fast-growing monoculture plantations, evenly spaced in uniformed rows. Simard's father was a "tolerant" man, she recalls, but he found it hard to see the forest he had spent his life in being cut down. Simard herself was troubled by what she saw as the ecological impact of clearcutting. Clearcuts, she recalls, were "ugly, hot places" with no shade, no cover, no birds, no life. The planted seedlings had trouble growth and thus required more light and water than trees in a mature forest. Simard, even as a young girl, felt the environment that the trees were meant to live in was not. Underground, trees and fungi form partnerships that are as intimate as any in the natural world, and have with their roots, helping them extract water and nutrients like phosphorus and nitrogen in exchange for the sugars they make through photosynthesis. Research had demonstrated that mycorrhizae also connected trees of different species, and that they could transfer nutrients from one tree to another. Could the fungi also be a means of communication? Simard was not in the area for her doctoral thesis, Simard recalls, but she was "very, very interested" in the ecological relationships between trees in British Columbia. Apart from her experience, she didn't know much about forests, she was a biologist, but she felt that the old foresters were no. Why don't you just study growth and yield?" Simard was told. "I was more interested in what was underneath." Simard, "thought it was all very gritty."

Now a professor of forest ecology at the University of British Columbia, Simard, who is 62, has studied webs of root and fungi in the Arctic, Canadian and American forests and Australian eucalypts. For two decades, her critical writings about the importance of fungi in forest ecosystems have helped to make us aware how trees and fungi have evolved intertwined longlasting interrelationships about the ancient, vast, and hidden life of the forest and having the movement of nutrients through underground conduits. Simard has discovered that fungi can connect trees of the same or of the very, even hostile, species. Carbon, water, nitrogen, phosphorus, potassium and other nutrients flow to tree through these subterranean circuits. Trees in the same forest, Simard has discovered, share the same fungi. Fungi also form a kind of signal network, governed by one tree preparing "nodes" that can "talk" to other trees. Fungi, Simard has discovered, distribute carbon to trees in order to help them withstand overcrowding. And if a tree is on the verge of dying, the fungi will transfer the substantial stores of its carbon to its neighbors.

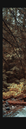
Although Simard's peers were skeptical and sometimes even disparaging of her early work, they have come to see her research as both groundbreaking and innovative scientists studying plant communication and cooperation. Her work is similar in the scientific and forest literature, she has published her published research as "transformed, imaginative, and, in some ways, poetic." Her work has been a Wisdowski biology professor who has studied mycorrhizal networks, agrees "I think she has really opened up the field." Simard's work, he adds, has made many fellow in ecology and are actively sought to promote clear classes on forestry and ecology. Tree ecologist Dr. Massimo Nicolini, who studies the Italian Alpine Forests (UNESCO Pollaga Pine carving), says, "Suzanne's work has been very important for us." Wisdowski, Nicolini, Nicolini, Kropf and publish Simard's own work, Simard's work has been "very important." Jeremy Kropf, a forest ecology professor at Oregon State, says that "she forest was more than just a collection of trees."

Some theorists, biologists have emphasized the perspective of the individual. They have stressed the competition between individuals, the struggles and struggles of each species to survive and reproduce within a given population and, underlying it all, the "selfish" nature of genes. Simard, for her part, has said that "someone using scientific terms sometimes sounds like a jerk." Simard, for a people focus on cooperation, "I'm a people focus on the cooperative properties of life's systems, rather than their units.

Suzanne Simard, who studies the ecological relationships between trees in British Columbia, wrote her doctoral thesis on the "mycorrhizal networks" that connect trees of different species.

Before Simard and other ecologists revealed the intricate, intimate, and ancient relationships between trees and fungi, most people had never heard of mycorrhizal networks. Indeed, the idea that trees could communicate with one another, let alone that Simard and her peers have demonstrated that this communication is mediated by fungi, would have been a coffee or cocktail party conversation stopper. Interacting one another's presence can a merciless "Stick a fork in me, I'm done" kind of conversation. There is conflict in a forest, there is also cooperation, reciprocity and perhaps even altruism. Trees, Simard has discovered, fungi and microbes in forest are as thoroughly connected, interdependent and cooperative as any ecosystem scientists have described from an supercomplex, Nobel Prize-winning Ecologist Elinor Ostrom's study of Swiss Alpine meadows. Ecologist Ursula Kropf, Ursula — essentially everywhere there is life on Earth. Life, Simard has discovered, is not a Darwin's zero-sum, cutthroat, living networks of unfathomable scale and complexity. "I was thought of as a kind of a hippie," Simard said. "I'm a kind of a hippie." Simard tells me. "It's not how a forest works, it's not how life works."

In the summer of 2015, I met Simard in Nelson, a small town in southern British Columbia. One morning we gave us a northern British Columbia. One morning we gave us a northern British Columbia. One morning we gave us a north



Redwood trees in Humboldt County, California

The emerging understanding of the ecology of fungi has urgent implications for how we manage forests.

Humans have relied on forests for food, medicine and shelter for millennia. Over the last millennium, many forests have been provided substantial amounts of shelter for countless species over the ages. But they have not provided much food for humans. Instead, forests function as some of the planet's vital organs. The colonization of barely plants between 420 and 360 million years ago, for example, helped cool the planet's surface. Forest cover is essential for carbon sequestration, and forests have been so for millennia. Forests suffuse the air with water vapor, fungal spores and microbial communities, and they do so by collecting rainwater and providing much needed anchorage to inland areas that would otherwise be prone to erosion and landslides. Collectively, forests store between between 400 and 1,000 gigatons of carbon, potentially exceeding the atmosphere's carbon.

Currently, a majority of the carbon resides in forest soils, anchored by networks of symbiotic roots, fungi and microbes. Yet, the ability of forest ecosystems to store carbon is being threatened by climate change, but deforestation – by destroying and removing trees – is also a major factor in the loss of forest carbon – can potentially shorten that effect. Where a forest is cut down, the carbon stored in the forest floor and in the soil is released into the atmosphere rather than being sequestered in the wood. Forests also provide a major source of fresh water. Forests influence the amount of water in the atmosphere, fungal communities and microbes

We, too, are composite creatures.

Diverse microbial communities inhabit our bodies, modulating our immune systems and helping us digest certain foods. The energy-producing organelles in our cells known as mitochondria were once free-swimming bacteria that were subsumed early in the evolution of multicellular life. Through a process called horizontal gene transfer, fungi, plants and animals — including humans — have continuously exchanged DNA with bacteria and viruses. From its skin, fur or bark right down to its genome, any multicellular creature is an amalgam of other life-forms. Wherever living things emerge, they find one another, mingle and meld.

Five hundred million years ago, as both plants and fungi continued oozing out of the sea and onto land, they encountered wide expanses of barren rock and impoverished soil. Plants could spin sunlight into sugar for energy, but they had trouble extracting mineral nutrients from the earth. Fungi were in the opposite predicament. Had they remained separate, their early attempts at colonization might have faltered or failed. Instead, these two castaways — members of entirely different kingdoms of life — formed an intimate partnership. Together they spread across the continents, transformed rock into rich soil and filled the atmosphere with oxygen.

Eventually, different types of plants and fungi evolved more specialized symbioses. Forests expanded and diversified, both above- and below ground. What one tree produced was no longer confined to itself and its symbiotic partners. Shuttled through buried networks of root and fungus, the water, food and information in a forest began traveling greater distances and in more complex patterns than ever before. Over the eons, through the compounded effects of symbiosis and coevolution, forests developed a kind of circulatory system. Trees and fungi were once small, unacquainted ocean expats, still slick with seawater, searching for new opportunities. Together, they became a collective life form of unprecedented might and magnanimity.

After a few hours of digging up roots and collecting samples, we began to hike back down the valley. In the distance, the granite peaks of the Selkirks bristled with clusters of conifers. A breeze flung the scent of pine toward us. To our right, a furtive squirrel buried something in the dirt and dashed off. Like a seed waiting for the right conditions, a passage from “The Overstory” suddenly sprouted in my consciousness: “There are no individuals. There aren’t even separate species. Everything in the forest is the forest.”

Ferris Jabr is a contributing writer for the magazine. His previous cover story on the evolution of beauty is featured in the latest edition of “The Best American Science and Nature Writing.” He is currently working on his first book, which explores how living creatures have continually transformed Earth throughout its history.

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