Do Trees Talk to Each Other?

A controversial German forester says yes, and his ideas are shaking up the scientific world

A British Columbia rainforest, where Douglas firs soar more than 160 feet, supports 23 native tree species. (Diàna Markosian)

By **Richard Grant, photographs by Diàna Markosian**
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I'm walking in the Eifel Mountains in western Germany, through cathedral-like groves of oak and beech, and there's a strange unmoored feeling of entering a fairy tale. The trees have become vibrantly alive and charged with wonder. They're communicating with one another, for starters. They're involved in tremendous struggles and death-defying dramas. To reach enormousness, they depend on a complicated web of relationships, alliances and kinship networks.

Wise old mother trees feed their saplings with liquid sugar and warn the neighbors when danger approaches. Reckless youngsters take foolhardy risks with leaf-shedding, light-chasing and excessive drinking, and usually pay with their lives. Crown princes wait for the old monarchs to fall, so they can take their place in the full glory of sunlight. It's all happening in the ultra-slow motion that is tree time, so that what we see is a freeze-frame of the action.

My guide here is a kind of tree whisperer. Peter Wohlleben, a German forester and author, has a rare understanding of the inner life of trees, and is able to describe it in accessible, evocative language. He stands very tall and straight, like the trees he most admires, and on this cold, clear morning, the blue of his eyes precisely matches the blue of the sky. Wohlleben has devoted his life to the study and care of trees. He manages this forest as a nature reserve, and lives with his wife, Miriam, in a rustic cabin near the remote village of Hümmel.

Now, at the age of 53, he has become an unlikely publishing sensation. His book The Hidden Life of Trees: What They Feel, How They Communicate, written at his wife's insistence, sold more than 800,000 copies in Germany, and has now hit the best-seller lists in 11 other countries, including the United States and Canada. (Wohlleben has turned his attention to other living things as well, in his Inner Life of Animals, newly issued in translation.)

Wohlleben sees a forest as a superorganism of unique individuals. A single beech tree can live for 400 years and produce 1.8 million beechnuts. (Diàna Markosian)

A revolution has been taking place in the scientific understanding of trees, and Wohlleben is the first writer to convey its amazements to a general audience. The latest scientific studies, conducted at well-respected universities in Germany and around the world, confirm what he has long suspected from close observation in this forest: Trees are far more alert, social, sophisticated—and even intelligent—than we thought.

With his big green boots crunching through fresh snow, and a dewdrop catching sunlight on the tip of his long nose, Wohlleben takes me to two massive beech trees growing next to each other. He points up at their skeletal winter crowns, which appear careful not to encroach into each other's space. "These two are old friends," he says. "They are very considerate in sharing the sunlight, and their root systems are closely connected. In cases like this, when one dies, the other usually dies soon afterward, because they are dependent on each other."

Since Darwin, we have generally thought of trees as striving, disconnected loners, competing for water, nutrients and sunlight, with the winners shading out the losers and sucking them dry. The timber industry in particular sees forests as wood-producing systems and battlegrounds for survival of the fittest.

There is now a substantial body of scientific evidence that refutes that idea. It shows instead that trees of the same species are communal, and will often form alliances with trees of other species. Forest trees have evolved to live in cooperative, interdependent relationships, maintained by communication and a collective intelligence similar to an insect colony. These soaring columns of living wood draw the eye upward to their outspreading crowns, but the real action is taking place underground, just a few inches below our feet.

"Some are calling it the 'wood-wide web,'" says Wohlleben in German-accented English. "All the trees here, and in every forest that is not too damaged, are connected to each other through underground fungal networks. Trees share water and nutrients through the networks, and also use them to communicate. They send distress signals about drought and disease, for example, or insect attacks, and other trees alter their behavior when they receive these messages."

Scientists call these mycorrhizal networks. The fine, hairlike root tips of trees join together with microscopic fungal filaments to form the basic links of the network, which appears to operate as a symbiotic relationship between trees and fungi, or perhaps an economic exchange. As a kind of fee for services, the fungi consume about 30 percent of the sugar that trees photosynthesize from sunlight. The sugar is what fuels the fungi, as they scavenge the soil for nitrogen, phosphorus and other mineral nutrients, which are then absorbed and consumed by the trees.

For young saplings in a deeply shaded part of the forest, the network is literally a lifeline. Lacking the sunlight to photosynthesize, they survive because big trees, including their parents, pump sugar into their roots through the network. Wohlleben likes to say that mother trees "suckle their young," which both stretches a metaphor and gets the point across vividly.

Once, he came across a gigantic beech stump in this forest, four or five feet across. The tree was felled 400 or 500 years ago, but scraping away the surface with his penknife, Wohlleben found something astonishing: the stump was still green with chlorophyll. There was only one explanation. The surrounding beeches were keeping it alive, by pumping sugar to it through the network. "When beeches do this, they remind me of elephants," he says. "They are reluctant to abandon their dead, especially when it's a big, old, revered matriarch."

To communicate through the network, trees send chemical, hormonal and slow-pulsing electrical signals, which scientists are just beginning to decipher. Edward Farmer at the University of Lausanne in Switzerland has been studying the electrical pulses, and he has identified a voltage-based signaling system that appears strikingly similar to animal nervous systems (although he does not suggest that plants have neurons or brains). Alarm and distress appear to be the main topics of tree conversation, although Wohlleben wonders if that's all they talk about. "What do trees say when there is no danger and they feel content? This I would love to know." Monica Gagliano at the University of Western Australia has gathered evidence that some plants may also emit and detect sounds, and in particular, a crackling noise in the roots at a frequency of 220 hertz, inaudible to humans.

Trees also communicate through the air, using pheromones and other scent signals. Wohlleben's favorite example occurs on the hot, dusty savannas of sub-Saharan Africa, where the wide-crowned umbrella thorn acacia is the emblematic tree. When a giraffe starts chewing acacia leaves, the tree notices the injury and emits a distress signal in the form of ethylene gas. Upon detecting this gas, neighboring acacias start pumping tannins into their leaves. In large enough quantities these compounds can sicken or even kill large herbivores.

Giraffes are aware of this, however, having evolved with acacias, and this is why they browse into the wind, so the warning gas doesn't reach the trees ahead of them. If there's no wind, a giraffe will typically walk 100 yards— farther than ethylene gas can travel in still air—before feeding on the next acacia. Giraffes, you might say, know that the trees are talking to one another.

Trees can detect scents through their leaves, which, for Wohlleben, qualifies as a sense of smell. They also have a sense of taste. When elms and pines come under attack by leaf-eating caterpillars, for example, they detect the caterpillar saliva, and release pheromones that attract parasitic wasps. The wasps lay their eggs inside the caterpillars, and the wasp larvae eat the caterpillars from the inside out. “Very unpleasant for the caterpillars,” says Wohlleben. “Very clever of the trees.”

A recent study from Leipzig University and the German Centre for Integrative Biodiversity Research shows that trees know the taste of deer saliva. “When a deer is biting a branch, the tree brings defending chemicals to make the leaves taste bad,” he says. “When a human breaks the branch with his hands, the tree knows the difference, and brings in substances to heal the wound.”

Our boots crunch on through the glittering snow. From time to time, I think of objections to Wohlleben’s anthropomorphic metaphors, but more often I sense my ignorance and blindness falling away. I had never really looked at trees before, or thought about life from their perspective. I had taken trees for granted, in a way that would never be possible again.

Wohlleben compares beeches to an elephant herd—"They look after their own, help their sick and are even reluctant to abandon their dead." (Diàna Markosian)

We reach an area that he calls “the classroom.” Young beech trees, in their own individual ways, are tackling the fundamental challenge of their existence. Like any tree, they crave sunlight, but down here below the canopy, only 3 percent of the light in the forest is available. One tree is the “class clown.” Its trunk contorts itself into bends and curves, “making nonsense” to try to reach more light, instead of growing straight and true and patient like its more sensible classmates. “It doesn’t matter that his mother is feeding him, this clown will die,” says Wohlleben.

Another tree is growing two absurdly long lateral branches to reach some light coming through a small gap in the canopy. Wohlleben dismisses this as "foolish and desperate," certain to lead to future imbalance and fatal collapse. He makes these blunders sound like conscious, sentient decisions, when they're really variations in the way that natural selection has arranged the tree's unthinking hormonal command system. Wohlleben knows this, of course, but his main purpose is to get people interested in the lives of trees, in the hope that they will defend forests from destructive logging and other threats.

Wohlleben used to be a coldhearted butcher of trees and forests. His training dictated it. In forestry school, he was taught that trees needed to be thinned, that helicopter-spraying of pesticides and herbicides was essential, and that heavy machinery was the best logging equipment, even though it tears up soil and rips apart the mycorrhizae. For more than 20 years, he worked like this, in the belief that it was best for the forests he had loved since childhood.

He began to question the orthodoxies of his profession after visiting a few privately managed forests in Germany, which were not thinned, sprayed or logged by machine. "The trees were so much bigger and more plentiful," he says. "Very few trees needed to be felled to make a handsome profit and it was done using horses to minimize the impact."

At the same time, he was reading early research about mycorrhizae and mother trees, and studies about tree communication coming out of China, Australia, the United States, the United Kingdom and South Africa. When he was ordered to clear-cut the forest near his home village of Hümmel—the fairy tale forest we've been walking through all morning—he invented excuses and prevaricated for several years. Then, in 2002, he went to the villagers and performed a mighty feat of persuasion.

After hearing his arguments, they agreed to give up their income from timber sales, turn the forest into a nature reserve, and allow it to slowly return to its primeval splendor. In 2006, Wohlleben resigned his state forestry job to become manager of the old beech forest for the town. Both Wohlleben and the villagers, perhaps, were tapping into the old German romanticism about the purity of forests.

To generate income, he created a wildwood cemetery, where nature lovers pay for their cremated remains to be buried in simple urns. "The trees are sold as living headstones," he says. There is some light horse-logging, and visitors also pay to take tours of the forest. For many years, Wohlleben led these tours himself, using lively, vivid, emotional phrasing to dramatize the largely inscrutable, ultra-slow-motion life of trees. People enjoyed it so much that Wohlleben's wife urged him to write a book along the same lines.

He has been taken to task by some scientists, but his strongest denouncers are German commercial foresters, whose methods he calls into question. “They don’t challenge my facts because I cite all my scientific sources,” he says. “Instead, they say I’m ‘esoteric,’ which is a very bad word in their culture. And they call me a ‘tree-hugger,’ which is not true. I don’t believe that trees respond to hugs.”

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Five-thousand miles away, at the University of British Columbia in Vancouver, Suzanne Simard and her grad students are making astonishing new discoveries about the sensitivity and interconnectedness of trees in the Pacific temperate rainforests of western North America. In the view of Simard, a professor of forest ecology, their research is exposing the limitations of the Western scientific method itself.

Suzanne Simard (in a Vancouver forest) uses scientific tools to reveal a hidden reality of trees communicating with their kin. (Diàna Markosian)

Simard is a warm, friendly, outdoorsy type with straight blond hair and a Canadian accent. In the scientific community, she's best known for her extensive research into mycorrhizal networks, and her identification of hyperlinked "hub trees," as she calls them in scientific papers, or "mother trees," as she prefers in conversation. Peter Wohlleben has referred extensively to her research in his book.

Mother trees are the biggest, oldest trees in the forest with the most fungal connections. They're not necessarily female, but Simard sees them in a nurturing, supportive, maternal role. With their deep roots, they draw up water and make it available to shallow-rooted seedlings. They help neighboring trees by sending them nutrients, and when the neighbors are struggling, mother trees detect their distress signals and increase the flow of nutrients accordingly.

In the forest ecology laboratory on campus, graduate student Amanda Asay is studying kin recognition in Douglas firs. (Ecologist Brian Pickles at England's University of Reading was the lead author and collaborator with Asay and others on the project.) Using seedlings, Asay and fellow researchers have shown that related pairs of trees recognize the root tips of their kin, among the root tips of unrelated seedlings, and seem to favor them with carbon sent through the mycorrhizal networks. "We don't know how they do it," says Simard. "Maybe by scent, but where are the scent receptors in tree roots? We have no idea."

Another grad student, Allen Larocque, is isolating salmon nitrogen isotopes in fungal samples taken near Bella Bella, a remote island village off the central coast of British Columbia. His team is studying trees that grow near salmon streams. "Fortunately for us, salmon nitrogen has a very distinctive chemical signature and is easy to track," he says. "We know that bears sit under trees and eat salmon, and leave the carcasses there. What we're finding is that trees are absorbing salmon nitrogen, and then sharing it with each other through the network. It's an interlinked system: fish-forest-fungi."

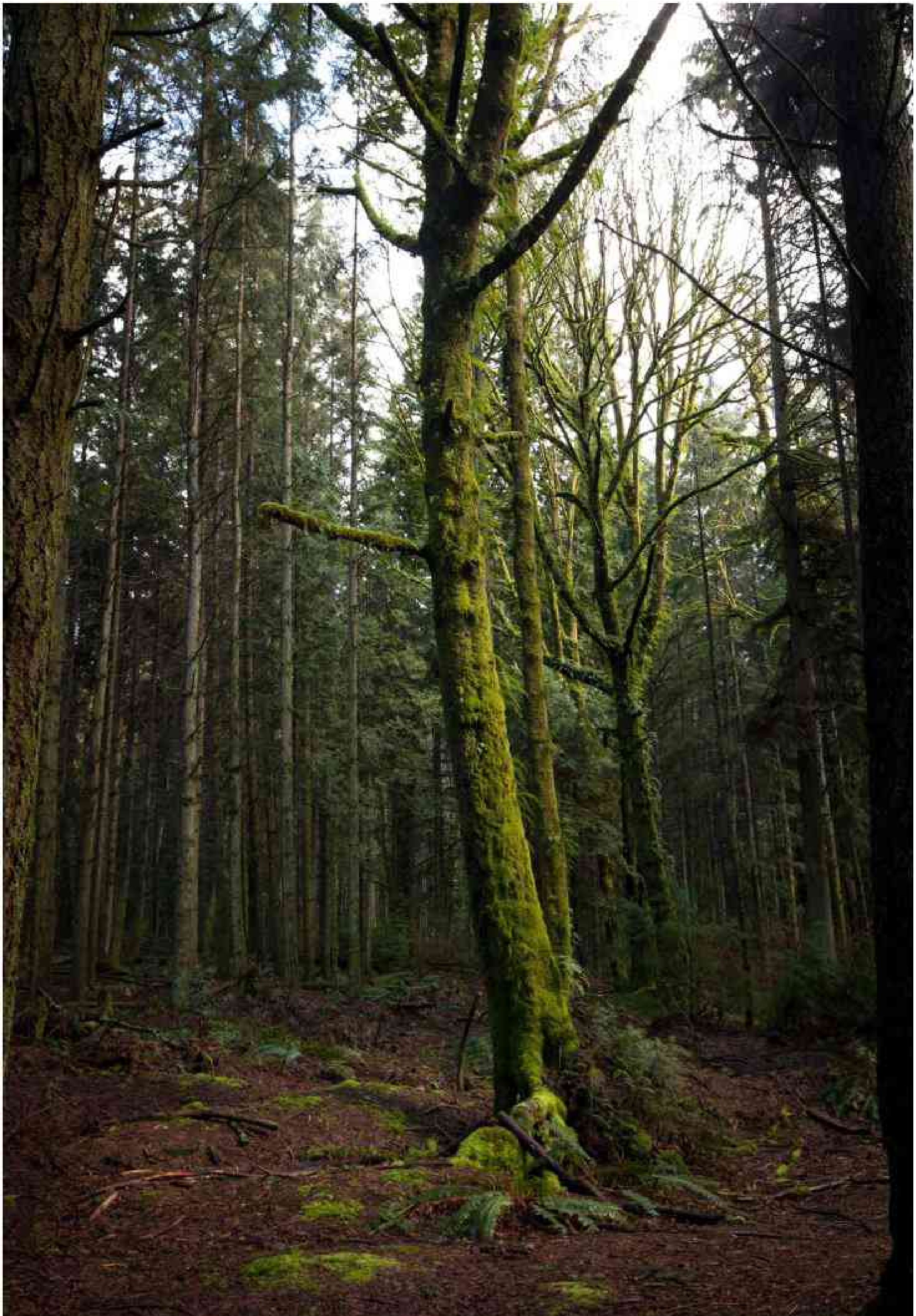
Larocque wonders what the best metaphor is for these exchanges, and for the flow of nutrients from mother trees to their neighbors and offspring. "Is it a sharing hippie lovefest? Is it an economic relationship? Or do mother trees just get leaky when they're old? I think all these things are happening, but we don't know."

Scientists are only just beginning to learn the language of trees, in Larocque's view. "We don't know what they're saying with pheromones most of the time. We don't know how they communicate within their own bodies. They don't have nervous systems, but they can still feel what's going on, and experience something analogous to pain. When a tree is cut, it sends electrical signals like wounded human tissue."

Over a sandwich lunch on campus, with Larocque listening carefully, Simard explains her frustrations with Western science. “We don’t ask good questions about the interconnectedness of the forest, because we’re all trained as reductionists. We pick it apart and study one process at a time, even though we know these processes don’t happen in isolation. When I walk into a forest, I feel the spirit of the whole thing, everything working together in harmony, but we don’t have a way to map or measure that. We can’t even map the mycorrhizal networks. One teaspoon of forest soil contains several miles of fungal filaments.”

After lunch, she takes me to a magnificent old grove of Western red cedars, bigleaf maples, hemlocks and Douglas firs. Walking into the forest, her face brightens, her nostrils flare as she breathes in the cool, damp, fragrant air.

She points to a massive, cloud-piercing giant with long, loose strips of grayish bark. “That red cedar is probably 1,000 years old,” she says. “It’s mother tree to the other cedars here, and it’s linked to the maples too. Cedar and maple are on one network, hemlock and Douglas fir on another.”



Forest networks feed rain systems, each tree releasing tens of thousands of gallons of water into the air annually. (Diàna Markosian)

Why do trees share resources and form alliances with trees of other species? Doesn't the law of natural selection suggest they should be competing? "Actually, it doesn't make evolutionary sense for trees to behave like resource-grabbing individualists," she says. "They live longest and reproduce most often in a healthy stable forest. That's why they've evolved to help their neighbors."

If neighboring trees keep dying, gaps open up in the protective forest canopy. With increased sunlight, the trees left standing can photosynthesize more sugar, and grow faster, but, Simard says, they're also more vulnerable and short-lived. The mycorrhizal support system weakens. In summer, more hot sunshine reaches the delicate forest floor, heating up and drying out the cool, damp, evenly regulated microclimate that such forest trees prefer. Damaging winds can penetrate the forest more easily, and without neighboring tree crowns to stabilize against, the chance of being uprooted increases.

Looking up at these ancient giants with their joined-together crowns, it's extraordinary to contemplate everything they must have endured and survived together over the centuries. Lethal threats arrive in many forms: windstorms, ice storms, lightning strikes, wildfires, droughts, floods, a host of constantly evolving diseases, swarms of voracious insects.

Tender young seedlings are easily consumed by browsing mammals. Hostile fungi are a constant menace, waiting to exploit a wound, or a weakness, and begin devouring a tree's flesh. Simard's research indicates that mother trees are a vital defense against many of these threats; when the biggest, oldest trees are cut down in a forest, the survival rate of younger trees is substantially diminished.

Unable to move away from danger, falling in catastrophic numbers to the human demand for land and lumber, forest trees also face the threat of accelerating climate change, and this is a major new focus of Simard's work. She recently launched a 100-year experiment on Douglas firs, Ponderosa pines, lodgepole pines and western larch in 24 different locations in Canada. She calls it the Mother Tree Project.

Asked to sum up its goals, she says, "How do you conserve mother trees in logging, and use them to create resilient forests in an era of rapid climate change? Should we assist the migration of the forest by spreading seeds? Should we combine genotypes to make the seedlings less vulnerable to frost and predation in new regions? I've crossed a line, I suppose. This is a way of giving back what forests have given to me, which is a spirit, a wholeness, a reason to be."

Not all scientists are on board with the new claims being made about trees. Where Simard sees collaboration and sharing, her critics see selfish, random and opportunistic exchanges. Stephen Woodward, a botanist from the University of Aberdeen in Scotland, warns against the idea that trees under insect attack are communicating with one another, at least as we understand it in human terms. “They’re not firing those signals to anything,” Woodward says. “They’re emitting distress chemicals. Other trees are picking it up. There’s no intention to warn.”

Lincoln Taiz, a retired professor of plant biology at the University of California, Santa Cruz and the co-editor of the textbook Plant Physiology and Development, finds Simard’s research “fascinating,” and “outstanding,” but sees no evidence that the interactions between trees are “intentionally or purposefully carried out.” Nor would that be necessary. “Each individual root and each fungal filament is genetically programmed by natural selection to do its job automatically,” he writes by email, “so no overall consciousness or purposefulness is required.” Simard, it should be noted, has never claimed that trees possess consciousness or intention, although the way she writes and talks about them makes it sound that way.

Taiz thinks that human beings are fatally susceptible to the mythology of thinking, feeling, speaking trees. In ancient Greece, trees delivered prophesies. In medieval Ireland, they whispered unreliable clues to leprechaun gold. Talking trees have starred in any number of Hollywood movies, from The Wizard of Oz to The Lord of the Rings to Avatar. Taiz sees the same old mythological impulse underlying some of the new claims about tree communication and intelligence, and the success of Wohlleben’s book and Simard’s TED talk “How Trees Talk to Each Other,” which garnered well over two million views online.

In 2007, Taiz and 32 other plant scientists published an attack on the emerging idea that plants and trees possess intelligence. He is willing to “be liberal and go along with the idea” that trees exhibit a “swarm intelligence,” but thinks it contributes nothing to our understanding, and leads us down an erroneous path toward tree consciousness and intentionality. “The appearance of purposefulness is an illusion, like the belief in ‘intelligent design.’ Natural selection can explain everything we know about plant behavior.”

From his house in Henley-on-Thames in England, the eminent British scientist Richard Fortey expresses similar criticisms. Now semi-retired, he was a paleontologist at the Natural History Museum in London, and visiting professor of paleobiology at Oxford. He has recently published The Wood for the Trees, about four acres of woodland that he owns in the Chiltern Hills. It is a magisterial work, and rigorously pruned of all sentiment and emotion.

“The mother tree protecting its little ones?” he says with gentle scorn. “It’s so anthropomorphized that it’s really not helpful. The case is overstated and suffused with vitalism. Trees do not have will or intention. They solve problems, but it’s all under hormonal control, and it all evolved through natural selection.”

When informed that Simard also detects a spiritual aspect in forests, Fortey sounds appalled. “Spiritual?” he says, as if the word were a cockroach on his tongue. “Oh dear, oh dear, well there’s nothing to be said about that. Look, trees are networkers. They do communicate in their own way. What worries me is that people find this so appealing that they immediately leap to faulty conclusions. Namely that trees are sentient beings like us.”

A notable offender in this regard, says Fortey, is Peter Wohlleben. “There’s a lot of good new science in his book, and I sympathize with his concerns, but he describes trees as if they possess consciousness and emotions. His trees are like the Ents in Tolkien’s The Lord of the Rings.”

When told about Fortey’s criticism, that he describes trees as if they possess consciousness and emotions, Wohlleben smiles. “Scientists insist on language that is purged of all emotion,” he says. “To me, this is inhuman, because we are emotional beings, and for most people, scientific language is extremely boring to read. The wonderful research about giraffes and acacia trees, for example, was done many years ago, but it was written in such dry, technical language that most people never heard about it.”

Wohlleben’s first priority is to not be boring, so he uses emotional storytelling techniques. His trees cry out with thirst, they panic and gamble and mourn. They talk, suckle and make mischief. If these words were framed in quotation marks, to indicate a stretchy metaphorical meaning, he would probably escape most of the criticism. But Wohlleben doesn’t bother with quotation marks, because that would break the spell of his prose. “Then one day, it’s all over,” he writes of a tree meeting its demise in the forest. “The trunk snaps and the tree’s life is at an end. ‘Finally,’ you can almost hear the young trees-in-waiting sigh.”

Does he think trees possess a form of consciousness? “I don’t think trees have a conscious life, but we don’t know,” he says. “We must at least talk about the rights of trees. We must manage our forests sustainably and respectfully, and allow some trees to grow old with dignity, and to die a natural death.” In rejecting the confines of the careful, technical language of science, he has succeeded more than anyone in conveying the lives of these mysterious gigantic beings, and in becoming their spokesman.

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