A man with short brown hair, wearing a light blue t-shirt and red shorts, stands in a dense forest. He is holding a clipboard and a pen, looking upwards towards the tree canopy. Sunlight filters through the leaves, creating dappled shadows on his shirt and the surrounding foliage. A large tree trunk is visible on the right side of the frame.

Before Henrik Hartmann began researching trees, he lived in a Canadian forest for a while.

Rooted in the Forest

Sometimes it takes a while for a person to find their vocation. **Henrik Hartmann**, for example, didn't attend university until he was at an age when others have already earned a doctorate. Today, the forestry scientist heads a research group at the **Max Planck Institute for Biogeochemistry** in Jena. And the things he experienced prior to studying were no less exciting.

TEXT **PETER HERGERSBERG**

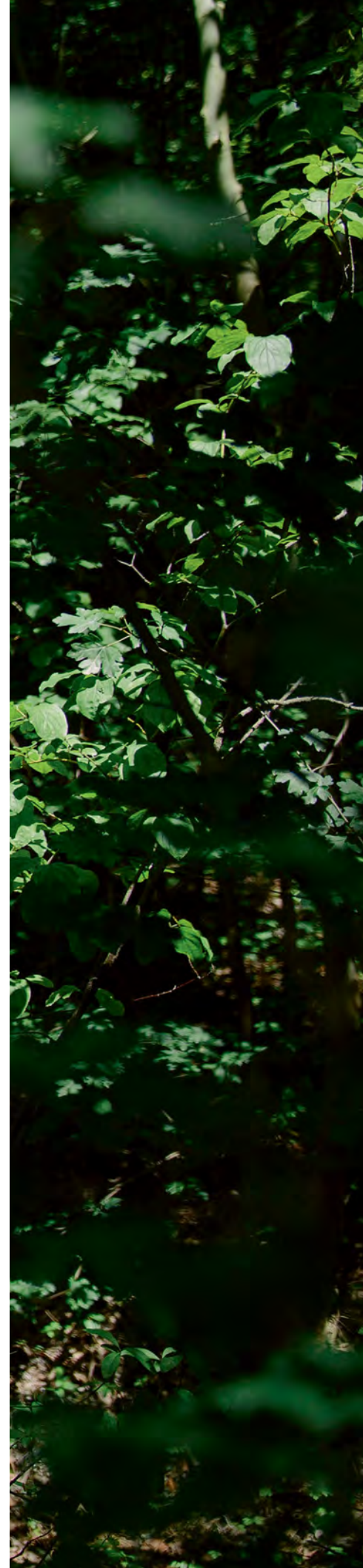
Henrik Hartmann's scientific inquisitiveness barely had a choice. As it gradually asserted itself and sought a purpose, Hartmann lived in a remote house in a Canadian forest, owned 45 hectares of it himself, made his own wood and worked in forestry. "Life there was dominated by the forest," he says. "And I trekked through it often enough." That led him to wonder why, in a hollow in his forest, he encountered only conifers, but a little further on, only birch, and then suddenly beech trees.

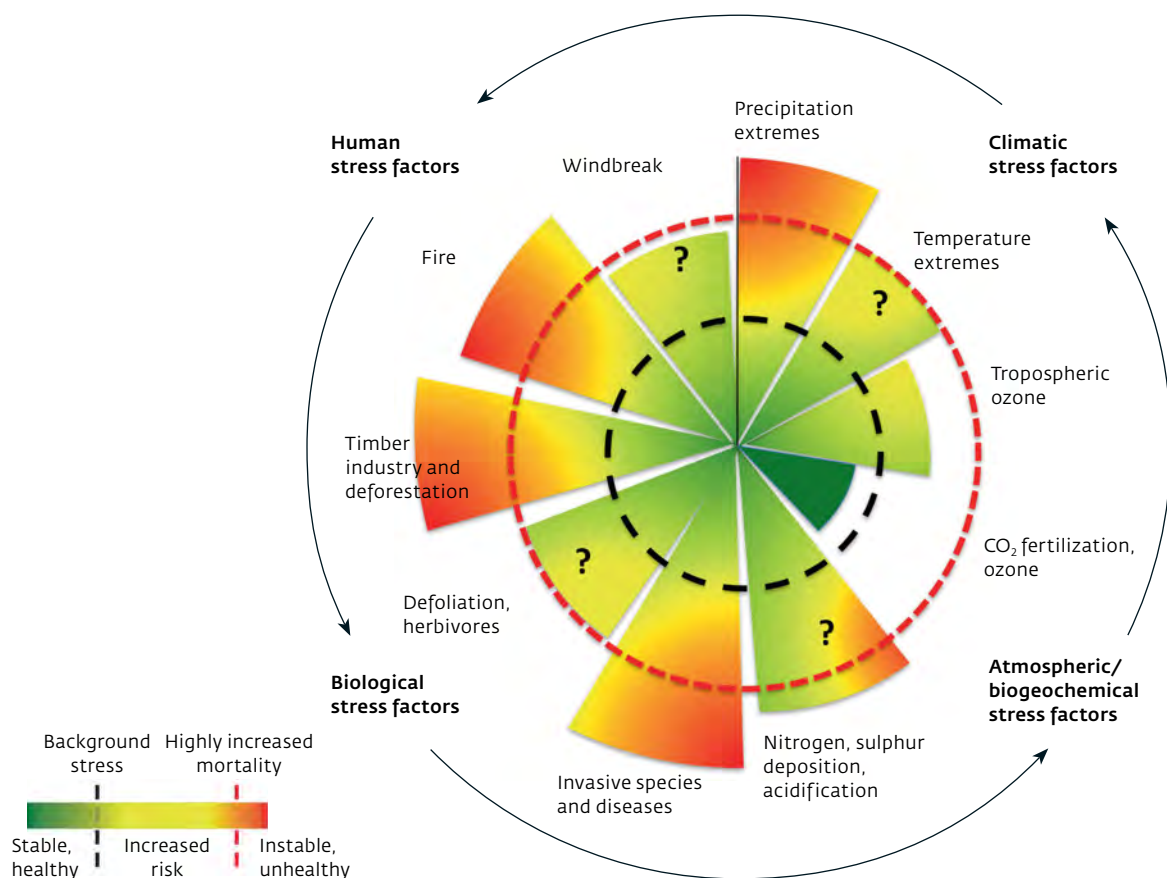
Hartmann, with his athletic build, sparse hair cut short, a thin goatee and an earring in his left ear, has an energetic step and a firm handshake – a guy who you immediately believe dragged two-meter-long tree trunks from the forest to his house using a homemade harness. Today, he is a Research Group Leader at the Max Planck Institute for Biogeochemistry and lives in Jena with

his Canadian wife, who also works at the Institute, and his three children. He researches why trees die if they don't get sufficient water or nutrients, and how they use scarce resources.

The water balance of trees is also the topic of a multi-day seminar in a branch of the Technical University of Munich in Freising – a mixture of internship and camping. Here, biology students learn how to measure physiological processes in trees, such as water transport. "Why is it important to study such processes on individual trees?" Hartmann asks the group. "One could also analyze the mass transfer of the whole ecosystem from a tall measuring tower. Wouldn't that be more important from a global perspective?"

The students piece the answer together with some effort: surveying individual trees reveals how different species manage resources and why some cope with changing environmental conditions better than others. As differ-





ent species assume different functions in the ecosystem, these findings shed light on how an ecosystem responds to droughts, for example, which are likely to be compounded by climate change. That's why Hartmann adopted the ecophysiology of trees as his topic.

WILL THERE STILL BE FORESTS IN 100 YEARS?

However, he also knows that the ecophysiology perspective is insufficient for making reliable statements about climate-induced global changes in forests. He therefore took the initiative and twice assembled his fellow researchers in workshops with representatives of other disciplines who deal with tree mortality, but who previously looked at it only with their own limited focus: researchers who analyze the state of the forest using satellites; those who inventory trees in the forest and assess their condition; and modelers who translate their colleagues' findings into computer programs to predict the

fate of forests in a warming world. "We also want to be able to tell politicians whether the forests we depend on will still exist in 100 years," the tree and forest researcher explains.

That Henrik Hartmann would one day initiate collaborative endeavors that give new impetus to his discipline wasn't apparent at as early a stage in his life as with other scientists. That's because his path to research was anything but straightforward.

He did at least announce to his mother at an early age that he wanted to become a scientist and study "how life works." He was just three years old at the time. But he didn't seriously tackle this goal until an age when others have already earned a doctorate. "I've always been close to nature; I walked in the forest a lot as a child," he says. "But I wasn't a forest freak who could already name 200 tree species at the age of six."

In Canada, Hartmann became, perhaps not a freak, but certainly a forest expert. His family still owns the house

and the forest in Auclair, a small village in eastern Québec. From there, he has to drive 25 kilometers to the nearest larger settlement with shops for everyday needs.

On a short hike to a lookout point overlooking the Max Planck campus in Jena, Hartmann talks about the time before he got into science. The SaaleHorizontale trail, a circular route that describes a wide loop around Jena along the slopes of the Saale valley, runs close by. Every year, a 100-kilometer march is hosted there – Henrik Hartmann has already participated three times with institute colleagues. They also did it for a good cause: for each kilometer they completed, the Max Planck staff collected money to fund, for instance, the education of a talented child from an underprivileged family.

Today, there isn't enough time for the SaaleHorizontale trail, but at least there is for Hartmann's story. He grew up near Dillenburg, in Hesse, Germany, between the Westerwald and Rothaar Mountains: "A beautiful scenic

Left page Numerous factors subject trees to stress. Inside the dotted black line, trees can cope well with this. However, if their influence crosses the dotted red line, they substantially increase tree mortality. The effects of some stress factors aren't yet known.

Right During his doctoral thesis, Henrik Hartmann collected samples with a chain saw. Today, he likes to use it to cut wood in his forest in Québec. He lived in the hut (image on the right) for two years with no running water or electricity.



area, but very rural." He gushes about what a wonderful woman his mother is. "She just should have been firmer with my father, perhaps – he was a very difficult person." Still marked by the National Socialist era, the war and the final total collapse, a house and car were his ideals, but they didn't bring him happiness.

HIGH SCHOOL DIPLOMA, THEN TWO YEARS OF MILITARY SERVICE

"I had no models," says Hartmann, when he explains why he didn't resolutely pursue the path to science from the outset. His teachers, for example, weren't passionate educators who could get their students excited about a topic. Some were more enthusiastic about their hobbies than they were about teaching, while others were still so strongly affected by the Second World War that they repeatedly shared their memories with their students. "Many seemed to have given up and to be rather out of place," says Hartmann.

After finishing high school, he initially enlisted for two years of military service. "I've never enjoyed doing what everybody else is doing," he says. The same applied to his decision about whether to do military service or alternative community service. "All my friends actually refused to do military service," he says. "And I thought: no, that's not right."

It was 1987, the world was divided into East and West and the Cold War wasn't over yet. "We were still looking down the barrels of millions of loaded weapons. If there was an equilibrium back then, it was only because the others were just as scared of us as we were of them." Nevertheless, he was happy when the two years had passed: "Toward the end, in particular, I often yearned for Friday on a Monday morning – there was too much, and often nonsensical, routine."

Then followed his first attempt at a university: he enrolled to study biology in Göttingen. Right in the introduction, the instructor announced that

only three of the 125 freshman students would actually get a job. Not exactly encouraging. Hartmann was soon drawn to Berlin. There began what he today regards as a period of breaking away from rigid social norms. And he makes no secret of it: "It's part of my biography, and it's better to have such a phase of discovery in your early 20s than in your late 40s, when it could potentially destroy a whole family."

In Berlin he lived to some extent as a *Heinzelmännchen*, as the local job placement office for students was called. "You could get really good jobs there." He worked this way for a few weeks here and there until he had amassed enough money to travel or go to concerts – his musical tastes ranged from punk rock to crossover and even reggae.

"I did this for a while until I'd had my fill and thought: there must be more," Hartmann says. In the early 1990s, an opportunity arose to travel to Canada with friends from Göttingen. This connection quickly crumbled, though, and Hartmann then first trav-



Left Hartmann's team studies where trees store sugar and other substances. To this end, the researchers use liquid nitrogen to freeze twigs, for instance, in an insulated vessel in order to grind them and analyze how much of the substances in question they contain.

Right page In the laboratory, Henrik Hartmann and his doctoral student David Herrera can precisely regulate how well they supply their test trees with carbon dioxide, for example. In addition, they measure the trees' gas exchange. They repeatedly cut off shoots to analyze different substances.

eled through the US. On an intermediate stop in New York, he realized he didn't want to return to Germany. In order for him to stay, his then girlfriend – a Canadian he had met in Germany – offered to marry him. "It was very fast and uncomplicated there," says Hartmann. Canadian immigration, on the other hand, took two years, during which time he lived from savings and janitorial jobs. "During that time, it became clear to me that I want to live in a forest somewhere."

So he and his then wife bought a reasonably priced plot of land with a wooden house and a hut that had been built in the 1930s and had hardly been altered since. The social dropout lived in the hut for more than two years, with no electricity, running water or sewer system. Hartmann collected water from a well near the house at the opposite end of the property. Sled dogs helped him in winter, but it was still quite laborious. He baked his own bread, starting with milling the grain. In winter, he had to shovel enormous

amounts of snow. There was also the young daughter the couple had since had. "You don't stop to question the sense of it all, things just have to be done, period," says Hartmann. But there was also little time for anything else – except maybe for meeting other dropouts in the area.

A SWOLLEN KNEE IS A FORTUNATE COINCIDENCE

"This intuitive life with very simple means is good – for a while," he says. It became clear to him that, "no, that can't be it. I have a background that includes education." At some point he felt like he had no identity: "And if I end up being a lumberjack, then I'm a lumberjack. But then I'll know what I am!"

So he started working, not as a lumberjack, but at a supplier of maple syrup harvesting equipment. This wasn't particularly good for his relationship with his wife, and they began to drift apart. "I told myself: I am now committed to my job." They separated and

he moved out of the hut and into the wooden house, where at least there was electricity.

There was also a setback with his job, which later turned out to be a fortunate coincidence. One morning, Hartmann's knee was swollen to the size of a handball; he couldn't work for a while. His boss terminated his employment, but supported him in enrolling for training as a forest warden. There, Henrik Hartmann asked more questions than the trainers had answers for. They often told him: "If you want to know that, you'll have to attend university, they'll explain it to you there."

"I found that amusing," says Hartmann with a slightly bitter laugh that accompanies many of his ironic remarks. "One would expect them to sit down and find out for themselves. But that's not how they were." He found this unsatisfactory and followed the advice that was probably not even meant seriously. After finishing his training, he studied forestry at the Université de Moncton in New Brunswick.



Although he was now getting on track professionally, today he describes this phase as the worst time of his life. The dispute over the custody of his daughter turned very nasty. Henrik Hartmann still seems very upset when he talks about it. A judge finally ended the dispute by saying that he didn't have time to examine the case in detail. Normally, children are better off with the mother, so the mother gets custody. The fact that he had since met his present wife and together they had been exercising custody of his daughter for more than a year did nothing to help the matter. "The court didn't really care that I had purposefully pursued my education and that my daughter would much rather have stayed with us. Because despite the burden of studying, the time spent with us was valuable to her, too." Hartmann felt and feels this to be deeply unjust.

Despite the exhausting dispute and the disappointment over the loss of custody, he completed his studies and – now at the Université du Québec – be-

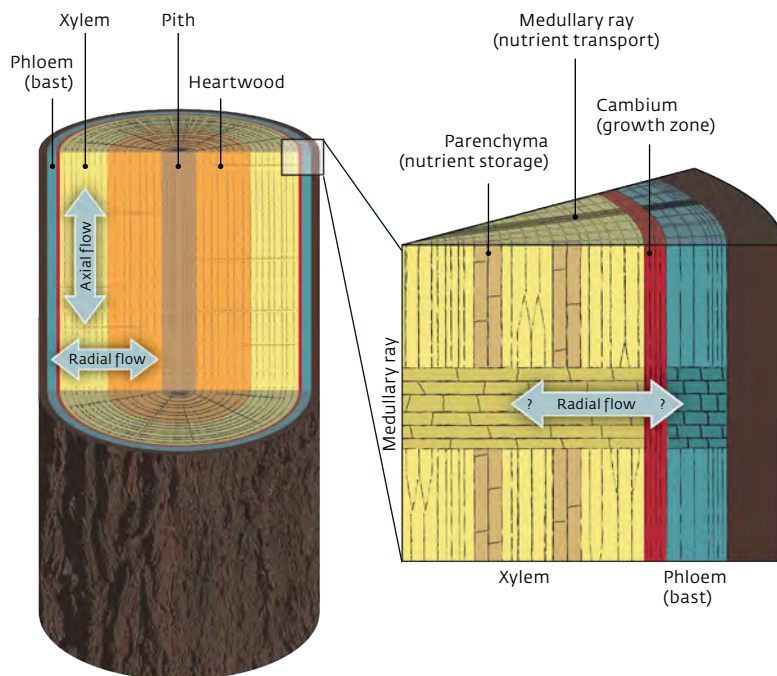
gan a master's degree, to which he immediately appended his doctorate. The topic of his dissertation: stress factors and mortality in selection silviculture forests. In selection silviculture forests, individual trees are removed in such a way that the stock always includes trunks of different thicknesses.

THE LACKEY MOTH AFFECTS TREE VITALITY

Right at the beginning of his doctoral thesis, on June 9, 2005, Hartmann experienced his second birthday, as he calls it: together with a bachelor student, he was inspecting the areas for his field experiment. In a pickup, they drove along one of the forest roads used by numerous freight trucks, which were often quite fast. In a curve, a semi-trailer came toward them on their side of the road. Hartmann was just able to avoid a head-on collision, but his vehicle slammed under the side of the trailer and was thrown back about 30 meters by its rear axle. Afterwards, the

vehicle looked like nobody could have gotten out of it alive. His passenger, however, suffered no more than a few bruises, and he himself only broke a metacarpal in his hand and suffered a few cuts. "I still really can't believe it," says Hartmann.

The rest of his dissertation passed without further incident. Using dendrochronological methods, he studied whether the entire tree stock suffers when individual trees are felled. He therefore compared the growth rates, determined from the tree rings, of dead and surviving trees, and in this way documented when dips in vitality occurred. He compared these events with foresters' archival data on natural disturbances, such as large-scale defoliation by insects. "We couldn't identify any negative effect of selective felling on tree vitality, but the results clearly showed the influence of epidemics by lackey moth caterpillars." These pests can completely defoliate a tree and it then no longer forms the sugar that it needs to live. >



Left How trees manage metabolic products and where they store these for emergencies is still largely unknown. What is clear is that, in summer, sugar flows axially through the phloem, the bark's bast fiber, from the leaves to the roots, and in the opposite direction in springtime. However, the researchers aim to discover to what extent substances are also transported radially and stored and retrieved from living cells in the otherwise dead sapwood, and how this is controlled.

Right page To understand the metabolism and thus the carbon balance of trees, Henrik Hartmann and Susan E. Trumbore, Director at the Max Planck Institute for Biogeochemistry, capture the gases that a tree releases through its bark.

The doctoral thesis raised questions that continued to spur Henrik Hartmann on. Hunger need not mean the death of the tree; if it has access to reserves, it may survive lean times. He was now interested in how trees manage their resources, particularly when they are scarce. And which deficiencies lead, in the worst-case scenario, to their death. This led him, in 2009, to the Max Planck Institute for Biogeochemistry, where in 2006 he had met Christian Wirth during an internship. Wirth was a Research Group Leader at the Institute and offered Henrik Hartmann a postdoc position. The forestry scientist aimed to use isotope-labeled carbon dioxide to study the sugar balance of plants during periods of drought.

"When I returned to Germany after 15 years, I was surprised at how much the country had changed," says Hartmann. He attributed this primarily to the 2006 FIFA World Cup. "There was suddenly a much more cosmopolitan atmosphere. It was apparent that people of different cultures were welcome here." That's one of the reasons why he was happy to stay in Germany

and immediately brought his wife and his now three children with him.

Initially, however, his research didn't progress as he had hoped. For weeks, he was unable to carry out his investigations. He passed the time by writing a review in which he summarized the state of research on the question of whether trees are more likely to suffer from thirst or hunger during droughts, which are likely to increase with climate change. Colleagues in the field still ask him about the article today. At the time, they were surprised they weren't familiar with the author.

TO FIND OUT HOW TREES DIE, YOU HAVE TO KILL THEM

The article begins by praising trees, which tells us how fascinated Hartmann is by these organisms. Nevertheless, he repeatedly kills trees – "I belonged to the tree-killer community," he says. "Because if you want to find out how trees die, you also have to kill them."

In his first experiments at the Max Planck Institute in Jena, for example, he allowed spruce to die of thirst and thus discovered that they perish be-

cause the roots starve to death; without water, the supply of carbohydrates from the needles fails. To understand how trees manage their resources in times of crisis, it helps to know how they handle them when there is no shortage. For this reason, Henrik Hartmann today investigates what trees normally do with vital substances – not just sugar, but also substances that defend against pests, for example.

As a scientist, he has clearly found his identity – but it's not all smooth sailing: "In terms of job description, being a researcher is my dream job. But the conditions for scientific work are sometimes difficult." Hartmann currently attends numerous conferences to make himself and his research known. "In my situation, I sometimes simply can't afford to say no," he explains. "I don't want to have to tell myself in three years: if only you had gone there back then and made that contact, you may have gotten a job."

What bothers him about the numerous trips isn't only that his work at the Institute goes undone: "The papers waiting for me to work on them are beginning to pile up." He is also con-



Photo: Sven Doering

scious of what he's putting his family through with the many trips: "I sometimes feel guilty when I leave my dear wife alone again with all the work at home." That's also a matter of fairness.

And then there's climate change, to which he is contributing with the flights – recently from Frankfurt to San Francisco, for instance. As an example, scientists from the Max Planck Institute for Meteorology calculated how much Arctic sea ice disappears for precisely this flight. "The paper was published a week before I boarded the flight," he explains. "I thought: oh great!"

Even though he pursues primarily basic research, he hopes his work will help make forestry and agriculture more sustainable and mitigate the effects of climate change. "I think that, as scientists, we have a duty to give something back to society – in the end, this is certainly more important than a NATURE paper." That is why he plans, together with Susan Trumbore, Director of his department, and Jonathan Gershenzon, Director at the neighboring Max Planck Institute for Chemical Ecology, to bring together scientists, politicians and plantation owners at a round table in Brazil. "That's where the soy we feed our pigs is grown," he says. "You can't take that away from the people, they depend on it. But we can try to make it as sustainable as possible."

At the moment, however, he is mainly concerned with how to proceed when his position as Research Group Leader expires. After all, Hartmann published his postdoctoral thesis in 2017. In it, he summarizes his findings on which substances plants preferentially produce when resources are scarce. His conclusion is simultaneously the title of the paper: *You can't always get what you want*. In the meantime, he's already been invited to job interviews. "Prospects are looking very good right now," says Henrik Hartmann. "It would be quite something if I were to become a professor now after all." ◀