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Canada Research Chair in Molecular Biodiversity Paul Hebert (top right) and his team at the Centre for Biodiversity Genomics, University of Guelph, stand among a collection of over 5 million fully digitized specimens. (Photo: Jaclyn McKeown, University of Guelph)

Paul Hebert sits back and recalls the moment so vividly. The time when he was a curious six-year-old, spending hours a day exploring the backyard of his family's Kingston, Ontario, home.

"I was a biodiversity buff. My most memorable moments as a child are collecting insects."

Hebert wanted to know more about the insects he was collecting: their names, their purpose, and why they were important for life on the planet. Decades later, that childhood interest would morph into a profession.

“I’ve had a lifelong fixation with biodiversity,” says Hebert, now 74 years old, Canada Research Chair in Molecular Biodiversity, and a world-renowned biologist, “so I’ve always wanted to know the species that I encountered.”

In 2000, Hebert had a “lightbulb moment.”

“I was in the grocery store, and while walking the aisles, I considered the short numeric strings that comprise the barcodes used to discriminate items, and thought, ‘Wow, strings of DNA are really closely analogous to retail barcodes.’ We should be able to read short strings on DNA to tell species apart.”

Building on taxonomic expertise gained in his boyhood, Hebert went home and got to work.

“I reactivated my childhood passion for collecting moths and found that I could tell every species apart by reading their DNA barcode. ‘Wow,’ I thought, ‘if it works for this group of insects in my backyard, it should work for all animals on the planet.’”

It would be a massive undertaking, but that thirst for knowledge would fuel a global mission. By 2003, Hebert began to partner with other Canadian and international scientists. By 2010, this alliance expanded into the iBOL Consortium, which includes research organizations in 40 nations that have joined forces to advance the \$180 million BIOSCAN project. The group uses DNA sequencing to document every plant, every organism and every animal, whether on land, in the air or in water, and add them to a reference library, with a hefty goal of registering **all** multicellular species on our planet by 2045.

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Recognizing the team’s massive undertaking over several years, and the transformative potential of the project, BIOSCAN was awarded a \$24-million grant, over the next six years, through the [New Frontiers in Research Fund \(NFRF\) 2020 Transformation](#) stream, to extend the barcode library, probe species interactions, and study shifts in species distribution and abundance in response to global change. The grant will allow Hebert and his collaborators to track biodiversity trends across the globe, providing policy-makers with the data needed to support decision-making, while allowing anyone in the world to access the library from anywhere.

Hebert notes that this work has seen diverse practical implications.

“The Canadian Food Inspection Agency employs our methods to detect consumer fraud and track substitutions in products. We didn’t begin our work with the goal of establishing private enterprises,” he adds, “but there have been six spinoffs from our research centre, in fields as diverse as COVID-19 surveillance to probing the impacts of the off-shore oil industry on marine ecosystems off Newfoundland.”

“Human populations have expanded tremendously in my life,” says Hebert from the Centre for Biodiversity Genomics, which he founded at the University of Guelph. “We have been decimating the species that share our planet. We need to reverse this trend, and we certainly need to ensure it doesn’t get worse.”

This BIOSCAN project will also see further engagement with Indigenous communities in Canada and abroad.

“Indigenous People all over the world have been stewarding their lands and waters since time immemorial,” says Crystal Tremblay, an early career researcher and assistant professor of geography at the University of Victoria, who leads the BIOSCAN team in the area of community engagement and biodiversity. “They understand the intrinsic connection between species and just how sacred that is, and there is so much to learn from them.”

“BIOSCAN could advance the way that fisheries are managed and the way that our waterways are managed,” Tremblay adds. She believes it may extend collaboration between governments and Indigenous communities on a wide range of issues, including stewardship for salmon and salmon habitat. “I think this project has the capacity to do that.”

“It’s a form of forensic science,” says Melania Cristescu, Canada Research Chair in Ecological Genomics and professor of biology at Montreal’s McGill University, who specializes in aquatic biosurveillance. “Just as forensic scientists gather a small sample of blood from a crime scene to identify the suspect, we can probe environmental conditions by simply taking a water sample. We filter DNA from the water sample and can then identify all the organisms that live in that environment.”

Cristescu’s work can not only identify the species that live in the particular habitat, but it allows her team to see what genes are being turned on and off. It gives them a sense of how healthy the populations in our lakes and oceans are, and what habitats are under stress. “It gives us the best information we can use in order to implement protective measures,” she adds.

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The innovation doesn’t end there. The BIOSCAN team is applying that same technology used in water samples to measure DNA in air, and to discover the species in a grid that spans the planet.

“It’s magic.” Hebert jests. “Our colleagues are finding that they can simply filter air and read species living in the vicinity—the birds flying through the air, the mammals on the ground. How cool is that?”

It’s very cool to the inquisitive six-year-old boy who still fuels Hebert’s work—now watching his dreams come true.

“That boy is pretty thrilled to be able to tell every species apart,” he laughs, “but I’m thinking of the world that my seven-year-old grandson is entering, and the things that will be possible in his lifetime. His generation must do a much better job of curating nature.”

While the funding through NFRE (New Frontiers in Research Fund) is for a six-year project, it will take much longer—24 years—for the BIOSCAN team to register all multicellular species on the planet. By then, Hebert will be 98. He hopes his legacy will impact future generations.

“It would be great to say, ‘Wow, we did it! We established a global biosurveillance system!’ I’ll also be happy to miss the grand finale, but to have been there at the start and to have had a lot of joy in aiding progress along the way. I have immense gratitude for our country and its willingness to support scientific enterprise.”

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