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For every species, a barcode: Guelph professor traces scientific breakthrough to grocery-store revelation

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GUELPH — On a warm summer night, you should find Paul Hebert in the backyard of his Puslinch home, gathering small moths in a trap.

If the University of Guelph professor finds a fluttering specimen of a sort he believes he's never come across, it will be examined, photographed and taken to Hebert's U of G laboratory — leading to the possibility of it becoming the latest of Earth's organisms to be catalogued through his International Barcode of Life Project.

A 63-year-old quick-witted bundle of energy, Hebert came by his love of bugs at an early age. One of five children born to a nurse and a draftsman in Kingston, Ont., Hebert's earliest memory is as a four-year-old when he cut himself on a piece of glass after catching a bee in a jar.

"I remember thinking I was going to die for collecting a bee. I wasn't smart enough to quit collecting bugs. It was a big fixation. Who knows why people are born with a passion for things?"

After graduating from Queen's University in Kingston, he did post-grad work in England and Australia. He then did research in New Guinea. Eventually, he landed at the University of Windsor, running its Great Lakes Institute. He came to Guelph in 1993 to head the now-defunct Department of Zoology.

Today he leads an international endeavour involving 25 countries and hundreds of scientists with the daunting task of creating a library of life.

"It's my dream really," he says, one that he plans on pursuing for the rest of his professional life.

"If I'm honest, I really can't see myself stopping doing bar-coding, so nature will intervene. I expect I will hit the forest floor while collecting a bug at some point. That's my hope. If I get to exit that way, I'll be very happy."

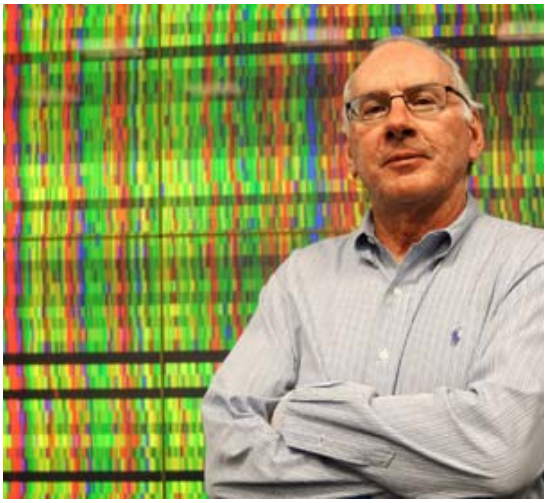
DNA barcoding uuses a small, specific strand of DNA from a species to identify it. The process is controversial but supporters in the science world see it as an effective, simple, quick and cheap way to identify living species. It is considered a huge breakthrough toward the long-held scientific goal of figuring out everything that lives on the planet.

The idea was hatched in a supermarket in 1998. Hebert and his wife of 40 years, Judith, were at the store and, as he looked around, he wondered why all the items in a grocery store could be identified by simply using 10 numbers of a barcode.

"I thought to myself, 'we can tell all these products apart with just 10 numbers? Why can't we do this with DNA?' "

While using DNA to identify species was not new, the idea of using the same small strand of DNA from each species to differentiate it from others was.

"Quite a few people came up with the idea of identifying a species by just a part of its DNA. But everyone was looking at a different part of that DNA."



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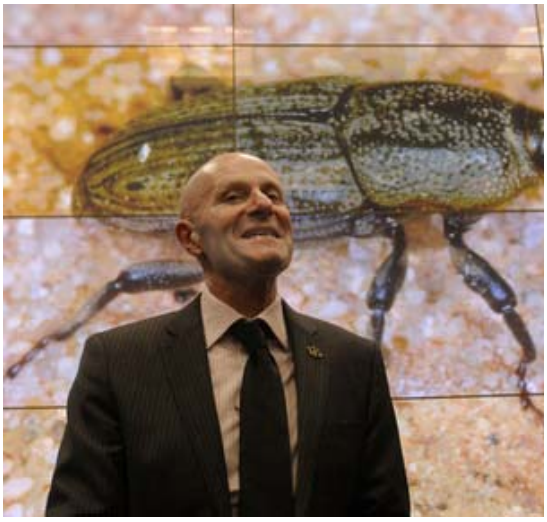
Paul Hebert, the godfather of DNA barcoding, stands in front of a series of DNA strands at the University of Guelph's Biodiversity Institute of Ontario.



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University of Guelph president Alastair Summerlee takes part in an $8.1 million funding announcement for the University of Guelph-based International Barcode of Life project at the university in April.

Hebert says DNA barcoding is about more than the abstract identification of species. It has huge practical implications, including learning about the rise and fall of species and the effect that environmental changes have on them.

On a practical level, Hebert sees the day in the near future where a hand-held device could be used to immediately identify an organism.

Uses range from identifying potentially dangerous crop bugs at a border crossing to knowing if the fish you are buying is actually what the restaurant says it is. A recent U of G study using DNA barcoding showed 25 per cent of fish was mislabeled in markets and restaurants.

Hebert, who introduced the process to the science community in 2003, says barcoding is 98 per cent accurate.

“We want to automate the identification of life and I don’t want to wait 25,000 years to finish the registration. We think we can do it in 25 years,” Hebert says.

In five years, 100,000 species have been identified using DNA barcoding. By 2015, the goal is to catalogue the DNA barcode of 500,000 known species.

There are an estimated 1.9 million known species on Earth, including animals, plants, fungus and micro-organisms. Some scientists suspect there are perhaps five times that amount yet to be discovered.

“Paul’s interest is not to recreate the evolutionary tree . . . but to come up with a practical tool that most of the time would give you a highly automated, very rapid, relatively cheap way of identifying these species,” says Christian Burks, president and chief executive of the Ontario Genomics Institute, a non-profit organization that promotes and helps raise funds for life science research and investment in the province.

“Paul is perceived and considered globally as the person that got this field off the ground and went well beyond ‘I published a paper and did some followup work and the record books will say this is my idea.’ ”

Headquarters for the barcoding initiative is the $12-million Biodiversity Institute of Ontario, a red-brick structure on the U of G’s western edge where Hebert occupies a small, second-floor office. Next year, the building — constructed just for the project — is scheduled to receive an $18-million expansion.

“We’ve gathered more resources than any other place on the planet,” Hebert says. “We are the secretariat of the project. We’re the force.”

Yet while governments around the world are pouring millions of dollars into research, fieldwork and infrastructure for the project, there are those in the scientific community who denounce DNA barcoding.

Many of these naysayers and critics suggest the process is flawed and that it’s pulling money and attention away from traditional scientific research on the identification of species.

Those critics include Daniel Rubinoff, an associate professor of entomology at University of Hawaii.

“I don’t know a single person who was opposed to it originally who has come around to seeing it as a worthwhile venture. This includes people in the U.S., Australia, Europe, and Canada,” Rubinoff wrote in an email. “While there are some cases where barcoding can work, that doesn’t justify using it as a global marker.”

He says he wonders about the impact of misidentifying species through the imperfect process.

“The only thing worse than not knowing, is thinking you know something when you don’t,” Rubinoff wrote.

Will Kipling, of the University of California, agreed via email with Rubinoff’s scientific criticisms and added that because barcoding has become such a hot item, scientists who express dissent about it “fear for their jobs and research funds.”

At the Ontario Genomics Institute, which has close financial ties with the barcoding project, Burks says the criticism is good and natural, but hints DNA barcoding is a bit of a white knight for an area that was receiving less and less support.

“Until barcoding came along, I don’t think there was any serious, or half-serious, proposal that we should catalogue life on the planet. Paul and his colleagues around the world have spoken for that now and feel barcoding can put us there,” Burks says.

Hebert is well aware of the criticism. It surfaced immediately after he presented his paper in 2003.

“There are some who feel we are pushing things a little hard,” Hebert says. He concedes the process is not 100 per cent reliable. But, he says, its failings are minuscule and even in the roughly two per cent of cases that it cannot be used to identify a species, it will narrow it down to two or three related species.

“We’ve never said it’s the ceiling,” Hebert says. ”It’s the floor for genetic analysis.”