

# The code of the wild

## **Merger of DNA technique, barcodes has potential for instant specimen ID**

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**By RACHEL EHRENBERG / Special Contributor to The Dallas Morning News**

You're camping in the woods when you realize you pitched the tent on what might be a nice, soft patch of poison ivy. The mushrooms your spouse picked look suspiciously poisonous. And you think that trout your daughter pulled from the stream is a protected species.

Don't panic. Get out your handy-dandy DNA barcoder. In the future, such a contraption may let you identify everything from salmon in the stream to slime mold in the basement, filling you in on the organism's natural history to boot.

A DNA barcoder would also make research a lot easier for people such as tropical ecologist Dan Janzen. "I read a lot of sci-fi in high school," he says. "And a recurrent theme is, the spaceship lands and the person comes out and sticks a gadget into something and the gadget tells them animal or mineral or plant, friendly or not friendly."

"I didn't see it coming as quickly as it got here, but it's been in my mind my whole life," says Dr. Janzen, who's made a career of getting a handle on the diversity of the tropics.

That gadget will be one of the payoffs of efforts to catalog the world's flora and fauna using a short sequence of DNA, or "DNA barcode." Two new studies demonstrate the usefulness of the project -- the Barcode of Life Initiative -- which was launched in 2003 by a number of major natural history museums and herbaria. The consortium promises the ultimate field guide, one that would allow rapid identification of and information about any of the world's estimated 10 million species.

The project is as ambitious as its potential applications are broad. Ultimately, a DNA barcoder could allow quick identification of disease-causing organisms (for example, that tick embedded in your leg is not carrying Lyme), protected species or invasive critters that threaten farmlands and forests. It could also help answer many

of the questions that keep biologists up at night, such as which animals live where, and who is eating whom.

A goal of the barcoding project is to have a reference chunk of DNA from the same part of the same gene for all creatures, a sort of Dewey Decimal System for the library of life.

However, not just any gene will do. The arrangement of letters in the DNA code changes over evolutionary time -- with some genes this happens very slowly and their DNA sequences look very much the same in closely related species. These genes are good for asking questions about the deeper branches in the tree of life.

But to get at questions about the tips of the evolutionary shrubbery, scientists must look at genes that are changing quickly.

One such gene in the animal kingdom is *cytochrome c oxidase I*, or *COI*. This gene changes quickly enough that its code reveals recent evolutionary events, allowing researchers to distinguish species from very close relatives.

"We had anticipated that there might be more complications than there are," says Paul Hebert of the University of Guelph in Ontario. "But the startling observation is, from whales ... to butterflies or birds, these organisms appear to all obey roughly the same sorts of rules in terms of the patterns of genetic variation."

This genetic variation helps scientists draw the line on what to call a species. Traditionally, experts sort species by looking at a number of traits -- what the organisms look like, how they behave -- and more recently, how their DNA varies. This genetic information can also unmask look-alike species: organisms that might look and act the same, but aren't breeding and are actually separate species. Revealing these cryptic critters is another promise of DNA barcoding, says Dr. Hebert.

Dr. Hebert, Dr. Janzen and their colleagues put this power to the test recently with a neotropical skipper butterfly, *Astrartes fuligator*. The little lepidopteron has long been regarded as a single species that lives in a variety of habitats from the southwestern United States to Argentina. But when more than 2,500 wild caterpillars of the skipper were closely examined, they hinted at hidden species.

Caterpillars of butterflies are usually loyal to their handful of food plants, yet the skipper caterpillars were caught chowing on a huge range of plants. "If this had been a moth I wouldn't have been so startled and annoyed by this long list, but no butterfly on earth eats 57 plants," says Dr. Janzen.

When the researchers sorted the adult butterflies by their caterpillar food plants, a pattern emerged: subtle differences in wing color, size and shape also fell into similar food plant categories, suggesting the skipper was a complex of six or seven species. Then the skipper's DNA barcode revealed that there were 10 species of butterfly, the researchers reported in a recent issue of the journal *Proceedings of the National Academy of Sciences*.

Dr. Janzen says the butterfly work illustrates where DNA barcoding would really shine: the tropics. There are so many species there, and there's so little known about them. Scientists may see a plant or animal only in one part of its life cycle -- a caterpillar on a plant, say, or a tree that isn't in flower -- so barcoding could allow a quick ID in the field, facilitating all kinds of investigations.

### Cautions, potential

Barcoding will be an important tool in temperate areas as well, but here scientists may have to tread a little more carefully, writes evolutionary biologist Craig Moritz in a commentary on a study published recently in *Public Library of Science Biology*.

Working mainly from museum specimens, a team of scientists led by Dr. Hebert surveyed the *COI* gene of 260 North American birds. The barcodes revealed four more hidden species: genetic variants within the sandpiper, meadowlark, marsh wren and warbling vireo. But many North American birds are migratory -- come fall, they get out of Dodge and head to the tropics. By sampling only temperate birds, the scientists may have missed their closest relatives, and therefore have a skewed version of the group's genetic variation.

As long as its limitations are recognized, the barcoding project has great potential, says Dr. Moritz, of UC-Berkeley, who calls the effort "a big challenge, and a very exciting one." Researchers need to be wary of other things that can complicate the genetic picture, such as hybridization, the mating of two different species. The *COI* gene is found in the mitochondria, the factories that make energy for cells. Mitochondrial DNA is usually passed on to offspring only by mothers, so it represents one snapshot of genetic variation. And it may not be the right gene to look at for all of life; in plants for example, a gene from the chloroplasts, the light-harvesting factories, might be a better candidate.

### Not a replacement

Some researchers worry that barcoding is intended to do away with the traditional ways of sorting species, replacing them with "DNA taxonomy." But proponents of the project say this concern is misguided.

"Our effort is built upon the idea of bringing in as much information as possible. It is a total evidence approach," says Dr. Hebert.

As with the bird and butterfly work, the preliminary thrust of the barcoding project will be sampling from museum specimens and getting the DNA library together. Technology isn't a limiting factor -- there are plenty of facilities that could do all of the lab work in about a year, says Dr. Hebert. Coordinating efforts and gathering funds is the crucial part right now.

Eventually the creatures' genetic code will be linked to an "encyclopedia of life," so that, gadget in hand, someone could retrieve not just a name, but also information on the animal's range, food and habitat preferences, and conservation status. This is the real importance of the barcoding project, says Dr. Janzen: It democratizes access to information about life on Earth.

"Right now it's like asking someone who can't read to save books," says Dr. Janzen. But barcoding "could transform the way that humans see the wild world. ... And maybe that will get more humans willing to work to save a fraction of that wild world."

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