Will DNA Bar Codes Breathe Life Into Classification?

Biologists hope that a simple tag on all forms of life, and even a hand-held reader, will make classification a 21st century science

LONDON—The sometimes-dusty world of taxonomy and biological collections held a revival meeting here last week. In the imposing surroundings of the Natural History Museum, on Charles Darwin's birthday, more than 220 experts from 46 countries gathered to discuss a new technology that could change their profession and—some predict—energize the museums in which they work. It makes use of short but specific DNA tags, or "bar codes"—parts of genes present in all living things—to distinguish one species from another. Enthusiasts aim to create a portable device that will identify an anonymous specimen by species and link to a database crammed with biological information. Proponents say they're going to "bar code the planet."

The Consortium for the Barcode of Life (CBOL), which convened the meeting,* wants to tag every organism on Earth, starting with the 1.7 million species that have been named and moving on to the estimated 10 million to 20 million that have not. CBOL's leaders foresee many applications, from fundamental research on biodiversity to enforcement of food laws, protection of wildlife, and even biodefense (*Science*, 13 June 2003, p. 1692).

It's a grand vision, but the London museum's science chief Richard Lane says it's feasible. He told reporters that a "proof of principle" for DNA tagging has been demonstrated in a study of North American birds, recently published by a group led by Mark Stoeckle of the Rockefeller University in New York City and Paul Hebert of the University of Guelph in Canada. Hebert meanwhile leads a group that's tagging fish in the northern Atlantic Ocean. During the meeting, researchers announced a third major project—one that uses a novel bar code for plants—which will test the method on 8000 plant species in Costa Rica. Partners in this project include scientists from Costa Rica, the Royal Botanic Gardens at Kew, U.K., the University of Pennsylvania in Philadelphia, and the Smithsonian Institution in Washington, D.C. (where botanist John Kress is developing a new plant bar code).

Hebert, dubbed the "father of bar coding" by Lane and others, explained one reason for the current optimism among those in the field:

Muddled over your moths? Just check the bar code.

CREDIT: CHIP CLARK/SMITHSONIAN INSTITUTION

The price for reading bar codes is dropping. Hebert developed what has become a standard method for DNA-tagging animals. It uses a small part of the mitochondrial genome, 650 to 750 bases of the cytochrome *c* oxidase I gene (COI), to provide a unique fingerprint. For most eukaryotes, COI variation appears to be lower among individuals within a species than among those from different species; in the study of North American birds, it is about 18 times lower. Hebert said the cost of testing a specimen for COI variation is now about $2, not counting labor, or about 10% of what it was 2 years ago. This prompted Lane to predict that bar coding all of life would be "relatively cheap in terms of other big science projects": less than $1 billion.

CBOL's executive secretary, David Schindel of the Smithsonian, said that the push has already begun. The big genome databases—GenBank in the United States and its partners in Europe and Japan—"quietly" set up a bar codes section this month that includes the precise location the specimen came from, he says. About 1000 entries have been made so far, according to Scott Federhen of the National Center for Biological Information in Bethesda, Maryland. Guelph's Hebert and Bob Ward of Australia's Commonwealth Scientific and Industrial Research Organisation aim to supply tags for 15,000 marine and 8000 freshwater fish by 2010. During this time Stoeckle and a group of collaborators plan to bar-code 10,000 bird species. In an independent project, Ann Bucklin of the University of New Hampshire, Durham, and colleagues are gathering bar codes on ocean plankton.

Some big obstacles remain. One is technical: Experts are not sure that simple bar codes will work for all species. Plants, for example, cannot be tracked with the COI gene. Kress proposes to use a combination that includes a bit of highly variable DNA between two genes on the chloroplast genome. It worked well in a test on Plummer's Island near Washington, D.C., he says, and is now being tried in Costa Rica. Amphibians also pose a challenge because for many, the COI gene varies so much from one individual to the next that it cannot be used reliably to mark species, said Miguel Vences of the Institute for Biodiversity and Ecosystem Dynamics in Amsterdam, the Netherlands. Herpetologist James Hanken, director of Harvard University's Museum of Comparative Zoology, suggested that for certain species such as the amphibians he studies, COI variation may need to be supplemented by extra tests. And very young species—including orangutans—may not be easily distinguished by COI bar coding.

Another challenge is to find money. Jesse Ausubel of the Alfred P. Sloan Foundation in New York City has steered support to this area and helped launch CBOL, he said, ever since hearing Hebert describe the idea in 2002. Others have joined in, but so far foundations have helped pay for start-up work. To scale up, research groups will need to tap into government budgets, and it remains to be seen how much policymakers want to spend.

Ausubel said the field is gathering momentum and that funding will follow. He pointed out that several companies sent delegates to the meeting and have invested in the field, including the bioprospecting firm Diversa Corp. of San Diego, California, gene chip maker Affymetrix of Santa Clara, California, and enzyme supplier New England Biolabs of Beverly, Massachusetts. Government agencies, including the U.S. Food and Drug Administration and the U.S. Department of Homeland Security, are also jumping in. "Environmental genomics is going to be huge," says Ausubel. But the prediction—like many at this meeting—comes from a true believer.

—**ELIOT MARSHALL**

* The First International Barcoding of Life Conference, London, 7 to 9 February (www.nhm.ac.uk/science/BOL).

Published by AAAS