Taxonomy

Name, rank and serial number

Biologists want to barcode half a million species in the next five years

THE tale of the unknown goby began in 1982 when Benjamin Victor, of the Ocean Science Foundation in Irvine, California, discovered an unusual fish in a reef in Panama. With only a single specimen he was hard pressed to prove it was a new species, so the fish remained, unnamed, on his desk for 25 years. Then, last year, he was sent an unusual fish larva. Using a new kind of DNA identification called barcoding he showed that it was a younger version of his mystery goby and that both specimens were, indeed, a new species.

DNA barcoding was invented by Paul Hebert of the University of Guelph, in Ontario, Canada, in 2003. His idea was to generate a unique identification tag for each species based on a short stretch of DNA. Separating species would then be a simple task of sequencing this tiny bit of DNA. Dr Hebert proposed part of a gene called cytochrome c oxidase I (COI) as suitable to the task. All animals have it. It seems to vary enough, but not too much, to act as a reliable marker. And it is easily extracted, because it is one of a handful of genes found outside the cell nucleus, in structures called mitochondria.

The idea worked, and it has dramatically reduced the time (to less than an hour) and expense (to less than $2) of using DNA to identify species. And thus, in July this year, Dr Victor's mystery goby became *Coryphopterus kuna*. It was the first vertebrate to have its DNA barcode—a sequence of about 600 genetic "letters"—included in its official description.

Barcoding has taken off rapidly since Dr Hebert invented it. When the idea was proposed, it was expected to be a boon to taxonomists trying to name the world's millions of species. It has, however, proved to have a far wider range of uses than the merely academic—most promisingly in the realm of public health.

One health-related project is the Mosquito Barcoding Initiative being run by Yvonne-Marie Linton of the Natural History Museum in London. This aims to barcode 80% of the world's mosquitoes within the next two years, to help control mosquito-borne diseases. Mosquitoes are responsible for half a billion malarial infections and 1m deaths every year. They also transmit devastating diseases such as yellow fever, West Nile fever and dengue. However, efforts to control them are consistently undermined by the difficulty and expense of identifying mosquitoes—of which there are at least 3,500 species, many of them hard to tell apart.

So far Dr Linton's team has used the COI gene to distinguish 390 species of mosquito, of which 7% have turned out to be new species. *Anopheles oswaldoi*, for example, was known to be a carrier of malaria in northern, but not southern, Brazil. That was puzzling. DNA barcoding, however, has shown that *A. oswaldoi* is actually four species, of which only one carries malaria. That explains the geographical discrepancy and should also assist efforts to curb the disease in Brazil by allowing the real culprit to be studied in detail.

Fly titles

The mosquito initiative has also had a piece of luck. Using some chemical wizardry, Dr Linton has been able to get barcodes from old, dried museum specimens collected as long ago as 1916. Between the Natural History Museum and the Smithsonian Institution in Washington, DC, 70% of the world's mosquito species are pinned and ready to be barcoded.

In a bid to track down the remainder quickly, Dr Linton plans, next month, to join a floating research institute—the *Scholar Ship*—that will be docked in Panama. There, she will offer a drop-in mosquito-identification service. All she asks in exchange for identifying mosquitoes is a copy of their barcodes. And Panama is only the first port of call. The ship will go on to sail around the world, offering a rapid-sequencing service wherever it docks; in half an hour, Dr Linton's machine can generate almost 100 barcodes.

Herbal medicines may also benefit. John Kress and David Erickson, who both work at the Smithsonian, have barcoded all 689 species listed in *World Economic Plants*. They intend to screen the content and quality of natural plant products used as medicines. In doing so, they have had to identify a new kind of barcode, as the COI gene is not found in plants.

Another group that could benefit from barcoding are customs officers, says Mark Blaxter, an evolutionary biologist at the University of Edinburgh. For those struggling to prevent the importation of pests or endangered wildlife, rapid and accurate identification tools are essential—particularly when perishable goods are being held up. America's Department of Agriculture is creating barcodes for the world's fruit flies. These are important agricultural pests and often arrive in the country as hard-to-identify larvae, or eggs, on fruit. Another group at the National Chung Hsing University in Taiwan (where hundreds of newly minted experts in the field have just met for the Second International Barcode of Life Conference) have created a prototype barcoding biochip. This is a collection of miniature DNA test sites on a sliver of glass that will rapidly discriminate between four species of fruit flies.

Barcoding's ease of use is also attracting interest from other government agencies. America's Federal Aviation Administration and its air force are working on bird barcoding. They want to scrape bits of tissue from planes, discover which birds are most often being struck, and thus work out which bird-migration routes to avoid. Another researcher, Mark Siddall, of the American Museum of Natural History in New York, has used barcoding to show that purported examples of *Hirudo medicinalis* (the medicinal leech approved by America's Food and Drug Administration as a prescription medical device for stopping blood clots) are sometimes another leech entirely.

Dr Hebert hopes to have half a million barcodes available online within the next five years. Both his laboratory at Guelph and the Smithsonian's Laboratories of Analytical Biology can sequence the COI gene rapidly, and have thus been dubbed "barcode factories", so this looks feasible.

In the long term, barcoding enthusiasts envisage something called a "barcoder". It will be a hand-held device that reads barcodes on the spot. The days will soon be over when a strange little fish waits a quarter of a century for a new name. ■