Cracking the code

DNA barcoding is set to uproot the 'tree of life' and revolutionise the way we classify animals. It may also have massive benefits for wildlife conservation. **Nick Atkinson** reports.

Men in tweed suits poring over dust-covered glass cases of countless inseparable insects, producing endless lists of unpronouncably named, endlessly dull descriptions of vanishingly obscure animals. Whether or not that was ever a fair caricature of taxonomy, it certainly won't hold true in the near future, according to the Consortium for the Barcoding of Life (CBOL). Members of the consortium, which include university researchers, museum curators, field biologists, conservationists and government policy makers, hope to achieve something extraordinary: to produce the first complete catalogue of living things – the definitive 'tree of life'. And they plan to use DNA barcoding to help them.

DNA barcoding is similar to DNA fingerprinting, in that it makes use of small fragments of the organism's genetic code to uniquely identify it. The feature that makes it so useful, however, is that the particular fragments used are found in all animals (efforts are currently underway to develop barcodes for the plant and fungal kingdoms, too). In particular, a short stretch of mitochondrial DNA, known catchily as 'cytochrome c oxidase subunit I' (thankfully, COI for short), has been shown to vary widely between species. As Darwin would have agreed, it's the variation that counts; though individuals belonging to the same species might have different COI sequences, the size of that difference is not as great as between individuals of two different species.

Laurie Campbell

Pure Scottish wildcat or tabby hybrid? DNA barcoding will clear up the confusion.

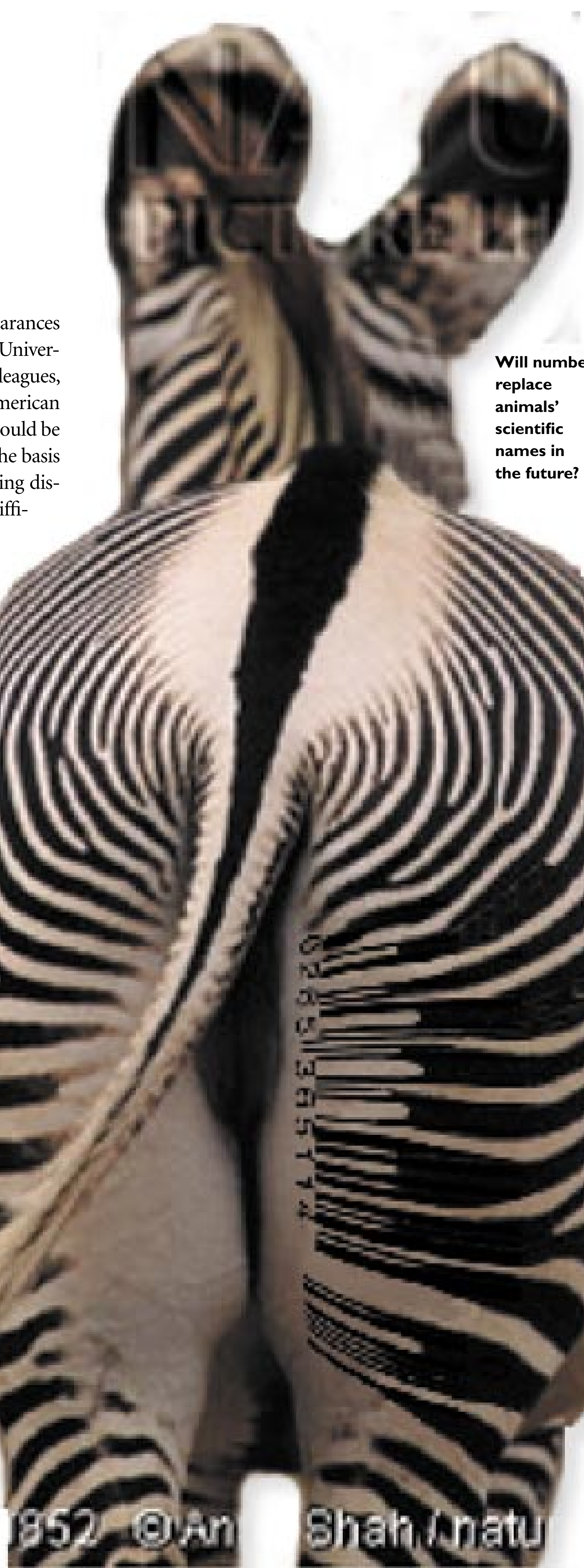
Taxonomists aren't sure whether there is any meaningful 'signal value' in the size of the differences between two individual's barcodes. For example, does a small difference mean that two individuals are more closely related in evolutionary terms than two individuals with a large difference? For the moment, therefore, they're developing DNA barcoding simply as a means of distinguishing species, even so it presents an impressively powerful new addition to the biologist's toolkit.

DNA barcoding might help us decide what is and what isn't a species.

Two recent studies have demonstrated the scope of DNA barcoding. In the first, samples were taken from all 260 known species of North American birds. The DNA barcodes were different for every species, but also yielded a surprising finding: in four cases, what had previously been considered a single species, actually appeared to be more than one. This is a phenomenon known as cryptic speciation because it's hard to see using traditional taxonomic methods.

The second study provided an even better example of how DNA barcodes might help untangle some of nature's mysteries. The neotropical skipper *Astraptes fulgerator* – a Costa Rican butterfly – isn't a single species after all. It's at least 10. Caterpillars and adult butterflies (and moths) are often difficult to pair up because they have such different appearances and habits. A study carried out by the University of Guelph's Paul Hebert and colleagues, who were also responsible for the American birds study, suggested that *A fulgerator* could be divided into at least 10 sub-species on the basis of their DNA barcodes. The most exciting discovery was that though adults were difficult, if not impossible, to tell apart, the 10 groups suggested by the barcode results corresponded perfectly with easily distinguished caterpillar forms. Again, a striking example of the way that DNA barcoding might help us decide what is and what isn't a species.

Why is all this so important? The CBOL wants to 'democratise taxonomy', by bringing the excitement of discovery out of the ivory tower and into the hands of everyday people: students, amateur naturalists, even ecotourists. Though the barcoding technology is still only available to universities and museums, the hope is that through a process of miniaturisation (of both size and cost) it will one day be possible to walk through a forest holding a device akin to Star Trek's tricorder.


852 ©An Shah/natu

Anup Shah/naturepl.com

Will numbers replace animals' scientific names in the future?

Pop in a sample of animal tissue or blood, press a button and wait for the result. You just discovered a new species! Many scientists believe this will accelerate our attempts to make an inventory of the world's biodiversity: the latest estimate is that around 10 per cent of species have so far been described.

This isn't science fiction, it's already happening. And it isn't just useful for producing those lists of living things; there are many practical applications of direct conservation value. One of these is helping in the fight against the trade in illegal bushmeat. By the time meat has been butchered, cooked or cured, it can be difficult to identify by visual means alone. Suspected poachers have used this to their advantage, claiming that what they are selling is simply beef, sheep or goat. Robert Hanner, scientific program director at the Coriel Institute for Medical Research, USA, has developed a method that allows the simple, rapid detection of primate bushmeat. "It works perfectly," he says. "The only trouble the system has is telling olive baboons from green baboons." Scientists have been arguing for years over whether they are really separate species – the barcode results suggest that they are not.

Wildcat rescue

Closer to home, DNA barcoding could come to the rescue of the Scottish wildcat. Wildcats are heavily protected, but they frequently interbreed with domestic cats and the resulting hybrids have no legal protection. Telling a 'true' wildcat can be extremely difficult, and has caused problems in enforcing its protected status. Could the barcode help? It's a possibility welcomed by the National Museum of Scotland's Andrew Kitchener, one of the handful of experts charged with protecting the last populations of this elusive predator. "Any method that advances our ability to identify wildcats quickly and accurately is very welcome as it will help us promote the conservation of this critically endangered species," he says.

DNA barcoding looks set to launch the science of taxonomy into the 21st century. A more complete 'tree of life' will surely bring direct human benefit in terms of understanding ecological relationships and the discovery of new medicines. But it should also benefit wildlife, whether it's through the direct conservation of primate species, fish stocks and other vulnerable populations, or simply through a greater appreciation of our planet.

Linnaeus's Tree of Life

Swedish naturalist Carl Linnaeus (1707 – 1778, *right*) first established the hierarchical method of naming living things that we still use today. The tenth edition of his *Systema Naturae*, published in 1758, is regarded as the official starting point of zoological nomenclature (naming of species) using a tree of life. It starts with three 'kingdoms', which in turn are broken down into classes, orders, families, genera and species of organisms. The major difference with today is that Linnaeus's groupings were based purely on shared physical characteristics instead of examining an organism's phylogeny – its evolutionary origins.

Linnaeus's concise binomial system, in which an organism has two names – the first is the genus, the second is the species – is also still in use. The Scottish wildcat, for example, has the Linnean moniker *Felis sylvestris*, belonging to the genus *Felis*. In fact, this refers to the European wildcat – the Scottish form is a subspecies known more precisely as *F sylvestris grampia*.

This binomial nomenclature allowed Linnaeus to classify all of the world's plants (7,700 species) and animals (4,400 species) known at the time.

Linnaeus's *Systema Naturae*, 1736, in which he demonstrated plant classification.

Both pictures Natural History Museum London

Website

Consortium for the Barcode of Life:
www.barcoding.si.edu/

Nick Atkinson is an evolutionary biologist and freelance writer. His scientific research is currently focused on the evolution of colour vision. Nick lives in Northumberland with his wife and family.