Science: Ivory signatures trace the origin of tusks

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WHILE conservationists are using military hardware and political clout to try to defeat poachers and save the African elephant, two research teams in the US are bringing more subtle techniques into the fray. Both teams use modern variants of fingerprinting to tell where the ivory comes from. One technique is based on an array of stable atomic isotopes, the other on genetic variation.

Nikolaas Van der Merwe of Harvard University uses the technique of isotope analysis to identify the origin of ivory. 'Whatever happens to policy on ivory trade,' he says, 'you need methods for pinpointing where a particular piece of ivory has come from, whether it is legally traded or illegally poached.'

Van der Merwe is an expert at determining what people ate in the past by analysing the isotopes in bones from archaeological sites. He became involved in the business of saving elephants through a chance meeting. 'I was working on some interesting sites in Kasunga National Park in Malawi a few years ago, and met Richard Bell, an elephant expert. He wanted some help with elephant diets, and we said we'd check it out for him.'

Van der Merwe talked to some of his friends in isotope analysis and realised that he might be able to develop an isotopic map of Africa's different elephant populations. He reasoned that populations of elephants live in widely different habitats across the continent, so their different diets might become 'imprinted' within their tusks. 'Animals that eat mostly grasses have a higher level of the carbon-13 isotope in their tissues than those that eat shrubs and trees.'

The reason for this variation is a subtle but critical difference in the chemistry of photosynthesis between grasses on the one hand, and trees and shrubs on the other. These differences, which are well established, affect the way the different carbon isotopes are used by the plants.

Van der Merwe applied his knowledge of the differences to his studies of diet from human bones. 'I've used the technique to pinpoint the introduction of maize into the diet of North American woodland Indians after AD 200,' he says. 'The signal is very clear.'

It took no great technical innovation to turn the technique into an anti-poaching device for protecting elephants. 'It seems to work, because the diets for particular elephant populations remain quite stable, so we get a reliable signal of the type of plant being eaten.'

However, it takes more than a single isotope to pinpoint any particular habitat reliably, because different places can sometimes have rather similar vegetation. 'We, therefore, use a second environmental signal - the ratio of nitrogen-15 to nitrogen-14 - to develop an isotopic fingerprint,' says Van der Merwe. 'In low rainfall areas, nitrogen-15 levels in animal tissues are elevated.' Although the correlation is quite strong, the underlying cause for it is not entirely clear. The researchers believe that it may have to do with the way that the animal deals with protein under the stress of drought conditions.

'We develop our isotopic fingerprint by plotting the figures for carbon against those for nitrogen,' explains Van der Merwe. 'For the most part, each particular geographical locality falls on a unique spot in this two-dimensional spread.' For instance, elephants' tusks from Tsavo Park in southwest Kenya have a distinctly different 'fingerprint' from those in the Shimba Hills Park, even though the two areas are only 150 kilometres apart. Elephants in Tsavo have high levels of both isotopes, indicating a grassy habitat with low rainfall.

For those occasions where figures for different localities run ambiguously close together, Van der Merwe and his colleagues suggest a third measure, the ratio of two strontium isotopes. 'This gives an indication of the geological background of a habitat, particularly whether the rock is old or young,' he says. 'The three isotopes, therefore, give you a three-dimensional fingerprint, which we believe will be unambiguous.'

So far, Van der Merwe and his colleagues have collected data on 100 elephants from 27 different African game refuges. 'We had to work round the clock to get these data for the CITES meeting,' says Van der Merwe, describing his preparation for the Convention on International Trade in Endangered Species held in Lausanne last week (see This Week, last issue). 'It's just a beginning.' The cost of collecting data for continent-wide fingerprinting will be about $300 000. But, he says, 'that's nothing compared with what's at stake'.

The second sophisticated technique that researchers propose to add to the anti-poaching arsenal is DNA fingerprinting. Already adopted as a powerful forensic tool, DNA fingerprinting identifies similarities and differences in the genetic makeup between individuals. According to John Patton of the University of Washington in Seattle: 'We will be able to exploit the technique to get genetic profiles of different elephant populations across the African continent.'

Patton's approach, in common with the technique of isotopic fingerprinting, should allow biologists to identify the geographical source of an isolated pair of tusks. 'I expect there to be sufficient genetic variation among different populations for a high degree of geographical resolution,' says Patton.

Tusks that have been hacked off an unfortunate elephant's jaw usually have enough soft tissue attached to them to enable researchers to extract DNA for analysis. And even when there is only a very small quantity of soft tissue, the molecular biologist's most recent magic tool - the polymerase chain reaction - comes to the rescue. Using this technique, researchers can amplify single molecules or fragments of DNA thousands of times, to produce enough material for analysis.

Patton's efforts are still at an early stage. 'I'm reasonably confident that we will get something that's workable,' he says, 'but it will take two to four years to find out.'

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