Identifying the origin of elephant ivory with isotopes

The international ivory trade remains one of the most controversial wildlife trade issues. In 1989, the international community listed the African Elephant *Loxodonta africana* in Appendix I of CITES, thus prohibiting any commercial ivory trade. The strict trade prohibition and effective protective measures allowed the elephant populations in some African countries to recover. One of the key findings in the latest African Elephant Status Report (Blanc *et al.,* 2007) is that elephant numbers in east and southern Africa are increasing by four percent annually. These two subregions hold 88% of all of the 'definite' and 'probable' elephant numbers recorded in the African Elephant Database. Botswana, Namibia, Zimbabwe and South Africa were given the opportunity to trade in elephant products under strict controls. Nevertheless, CITES has only allowed one-off sales and does not allow unrestricted trade of products made of elephant ivory. One of the main arguments for the trade prohibition is the fact that it is very difficult to distinguish legal ivory from illegal ivory in the markets, so that the legal ivory trade would provide a perfect cover for smuggling. However, in the medium-term, some African countries, in particular those with increasing elephant numbers, might insist that trade in ivory from their stocks should be allowed in order to generate continuous revenues for nature conservation (Ziegler, 2010).

Stable isotope analysis is a technique that relies on intrinsic tissue signatures to provide information on diet and often provenance of feeding. The use of this technique to trace the origin of wildlife is based on the fact that stable isotope signatures in animal tissues reflect those of local food webs and geology (Peterson and Fry, 1987; Tieszen and Boutton, 1988; Michener and Schell, 1994; Hobson, 1999). Van der Merwe *et al.* (1988) demonstrated that African Elephants from different regions had unique isotopic compositions. In an attempt to elaborate further the predictive ability of stable isotope signatures in ivory, WWF-Germany, in co-operation with the International Centre of Ivory Studies (INCENTIVS) at the University of Mainz, Germany, was contracted by the Federal Agency for Nature Conservation (BfN) to develop a methodology with which the determination of the geographical origin can be tested. The German Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU) partly funds this project, which will officially end in December 2013 (CITES, 2011).

In total, 606 ivory samples from 24 African and six Asian Elephant range States were collected from European museums and collections, trophy hunters and other individuals. CITES Management Authorities from Burkina Faso, Botswana, Malawi, South Africa, Mozambique and Sudan were particularly helpful and provided more than 350 samples. Several organizations, including TRAFFIC and the International Council for Game and Wildlife Conservation, promoted the project and extended the request for support to specific range countries. Ivory fragments of at least 30 mg were taken from different locations at the proximal end of the tusk by using a small handsaw, or alternatively a pincer, thus assuring that the isotopic signal reflected the environment where the animal had died. The samples were analysed at the Agroisolab facility for stable isotope research in Jülich, Germany. The authors combined various routine chemical analyses to measure the isotope ratios of the bio-elements hydrogen, nitrogen, carbon, oxygen and sulfur.

Stable isotope values of elephant ivory showed a considerable range of variation and there was significant overlap between regions. Therefore, approaches using single stable isotope markers are less practical to predict accurately the correct place of origin. Thus, multivariate statistics were applied and it was also found that combining isotopes increased the predictive power. The ratios of hydrogen, carbon and nitrogen, in particular, appear to be the most promising predictors in analysing isotopic fingerprints of elephant ivory. The authors also carried out assignment simulations and found that more than 95% of all ivory reference samples deriving from elephant populations listed in Appendix I of CITES were correctly assigned to their region of origin. Approximately 14% of all ivory samples from Botswana, Namibia, South Africa and Zimbabwe, whose elephant populations are listed in Appendix II of CITES, were misclassified as Appendix I populations. However, the authors are confident that the so-called false positive rate can be reduced if more reference samples are made available, particularly from Namibia and Zimbabwe. The results suggest that the combination of isotopic parameters have the potential to provide predictable and complementary markers for estimating the origin of seized elephant ivory. By pinpointing poaching hotspots with isotopic maps, wildlife authorities are in a better position to direct law enforcement efforts. Furthermore, the potential for unique isotopic markers, possibly in combination with other forensic techniques, increase the ability to distinguish legally derived ivory from illegally sourced ivory along the production and marketing chain.

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