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Isoscapes: a panacea to determine the provenance of illegally traded ivory?

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In the 1980s, the international trade in ivory led to a dramatic decrease of the African elephant population in many African countries. In an attempt to counter this decline, in 1989, the international community listed the species in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) thus prohibiting commercial ivory trade. Data from the CITES-affiliated information and surveillance system for trade and smuggle of elephant products show that since 2004, the illegal trade in ivory has been growing in several African countries. Long-term preservation of many of the African elephant populations can be supported with a control mechanism that helps with the implementation of remedial conservation action. Therefore, setting up a reference database that predicts the origin of ivory specimens can assist in determining smuggling routes and the provenance of illegal ivory. Our research builds on earlier work to seek an appropriate method for determining the area of origin for individual tusks. Several researchers have shown that the provenance of elephant ivory can be traced by its isotopic composition, but this is the first attempt to produce an integrated isotopic map of elephant ivory provenance. This map, termed "Isoscapes" systematically integrates a number of different databases from biology, geology as well as isotopic measurements of ivory to eventually allow a statistical determination of the provenance for seized ivory. We are referring to data of the African Elephant Specialist Group (AESG) from the International Union for the Conservation of Nature (IUCN), which has monitored the spatial distribution of elephant populations in Africa on a regular basis and has published their numbers in status reports. These reports contain vector data which spatially represent the range of the different elephant populations in Africa, and thus provide information on local vegetation and climate. Up to now, we collected 93 ivory samples of known geographical origin from museums and private collections in Europe, comprising 18 African elephant range states. However, most museum material did not provide additional information on the finding spot other than the country of origin. We applied a combination of various routine geochemical analyses to measure the stable isotope ratios of carbon, nitrogen, oxygen, hydrogen and sulphur. A regression function for the isotope composition of hydrogen in precipitation and collagen in ivory was developed and applied to overcome the problem of imprecise origin of some of the museum material. We further refined the likely source of provenance of this museum material by comparing the measured stable isotope ratios of carbon with superimposed layers of the MODIS Vegetation Continuous Fields and the Global Land Cover Map 2000 to predict spatial variations in the relative abundances of C3 and C4 vegetation which serve as food plants for elephants. We then computed isoscapes for hydrogen and carbon in elephant ivory using ordinary kriging. Our results suggest that combined maps for a range of isotopic parameters have the potential to provide predictable and complementary markers for estimating the origin of elephant ivory.