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Geographic variation of stable isotopes in African elephant ivory

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In 1989, the international community listed the African elephant in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) thus prohibiting commercial ivory trade. Recent surveillance data show that the illegal trade in ivory has been growing worldwide. 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 reference database of elephant ivory provenance. We applied a combination of various routine geochemical analyses to measure the stable isotope ratios of hydrogen, carbon, nitrogen, oxygen, and sulphur. Up to now, we analysed 606 ivory samples of known geographical origin from African range states, museums and private collections, comprising 22 African elephant range states. The isotopic measurements were superimposed with data layers from vegetation, geology and climate. A regression function for the isotope composition of the water isotopes in precipitation and collagen in ivory was developed to overcome the problem of imprecise origin of some of the sampled material. Multivariate statistics, such as nearest neighborhood and discriminate analysis were applied to eventually allow a statistical determination of the provenance for ivory of unknown origin. Our 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.