Determination of Age and Geographical Origin of African Elephant Ivory:

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Introduction to the Research Project

1. Necessity and backgrounds

Poaching of African elephants and illicit trade in ivory has accelerated in some African sub regions during the recent years. Trafficking in this illegal wildlife products today can be considered as professionalized as never been seen before. Well-organized and heavy-armed criminal bands do not only endanger elephant populations but also constitute a threat to regional stability, territorial integrity and sustainable social and economic developments of the countries concerned. International law enforcement, cross-border cooperation and effective forensic methods to uncover the structures and pathways of ivory smuggling and to differentiate illegal from legal ivory in trade are urgently needed.

Nowadays, *Loxodonta africana* can still be found in 37 range states in Sub-Saharan Africa, but certain populations, mostly in West Africa, hardly exceed a few hundred individuals which are highly threatened by increased poaching. At the time of the last continent wide assessment in 2007, the African elephant population was calculated to be at least 472,000 individuals, with possible numbers exceeding 690,000 elephants. 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 4% annually. These two sub regions hold 88% of all of the 'definite' and 'probable' elephant numbers in the African Elephant Database. ,In future some African countries, particular those with increasing elephant numbers, might insist that trade with ivory from their stocks should be allowed in order to generate continuous revenues for nature conservation and to be able to fight poaching more effectively.

A fine step forward to meet the still persisting problems of ivory smuggling and to avoid the intermixing of legal and illegal ivory, if decisions for restricted ivory trade will be taken in future, on the one side and on the other hand to meet all needs of all African range states could be to develop exact methods for the determination of age and geographical origin. Long-term conservation of the constantly declining elephant population of Western and Central Africa will only be possible with an efficient and reliable control mechanism readily in place that helps to identify the age and geographical provenance of confiscated ivory. Therefore, the African Elephant Action Plan by the African Elephant range states (CoP15 inf. 68) highlights the need for improved law enforcement and management by identifying the origin of seized ivory by using relevant analytic techniques (Activity 1.4.3. of Objective 1).

2. Evolution of the project

For several years the German CITES Management Authority of the German Federal Agency for Nature Conservation / FANC has repeatedly been confronted with the question of applicants and other authorities how the age of ivory designated for re-export could be determined. The University of Regensburg (Germany) was applying a method based on the analysis of radioisotopes and therefore the FANC got in contact with them. But this method was ambiguous in its informative value because in some cases not only one but two different results existed that differed up to 20 years. For this reason the University was working on a more precise method based on the analysis of several isotopes that showed better results with a higher degree of probability. The initiation of the research project enabled the University to proceed well and today a validated method for the age determination of ivory that can be applied worldwide by every laboratory equipped for these chemical analyses is available.

Right before the start of the research project the German University of Mainz and the WWF Germany approached the FANC because both had just started some research about how the geographical origin of elephant ivory can be identified by its isotopic composition. Therefore these two models were connected to cover both the parts 'age determination' and 'geographical origin' of ivory.

During the initial period of the project it seemed to be hard to obtain ivory samples that were necessary for the analyses. But soon some African CITES parties provided great assistance, like Botswana (ca. 50 pcs.), Burkina Faso (ca. 50 pcs.), Malawi (ca. 40pcs.) South Africa (ca. 100 pcs.) and Sudan (ca. 20 pcs.), as well as the Niassa Reserve of Mozambique (ca. 30 pcs.). The International Council for Game and Wildlife Conservation (CIC) offered their support by encouraging their members to provide samples, and later also the German Hunting Association (DJV), resulting in many samples started coming in continuously. Since the big game hunters knew the exact location where the elephant was hunted these samples were of excellent benefit for the project part 'geographical origin'. The Royal Museum of Central Africa in Belgium opened their inventory of ivory from the Democratic Republic of the Congo, making it possible for the FANC to take about 90 samples.

At the present time more than 600 samples from nearly 2/3 of the African Elephant range states could be integrated into the project. This high quantity made it possible to archive the well-founded results described in the project reports and summarized in the Inf-Doc. (please see the corresponding files on this USB-flash drive).

3. The Database

The results of the isotopic analyses of ivory samples of at least 30 mg, taken from the proximal end of the tusk by using a small hand saw or a pincer, were included into a provisional database. These chemical analyses were made at a laboratory in Jülich, Germany, the Agroisolab, using several continuous flow isotope ratio mass spectrometers (IRMS) and measuring five different stable isotope ratios (carbon($\delta^{13}C$), nitrogen ($\delta^{15}N$), sulphur ($\delta^{34}S$), oxygen ($\delta^{18}O$) and hydrogen ($\delta^{2}H$)).

The research results suggested that the combination of isotopic parameters has the potential to provide predictable and complementary markers to estimate the origin of seized elephant ivory. The predictive power of stable isotope signatures in ivory was improved through the combination of multiple isotope testing and multivariate statistics. The database for ivory can be used as reference

to predict the provenance of (seized) ivory of unknown origin. In some test runs applied to ivory from seizures (Leipzig, Germany, made in 2011, and Tianjin, China, made in 2012) some alleged poaching hot spots could be identified at country level. With this methodology, 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.

Even though we haven´t got ivory samples from all over Africa, one remarkable major result of the tests is that the ivory database will make it possible to distinguish between Appendix I and Appendix II populations. In assignment simulations more than 92% of all ivory samples from elephant populations listed in Appendix I of CITES were correctly assigned to their region of origin. Approximately 13% 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 (so-called 'false positive rate').

However, this rate will be reduced if more references samples are made available, particularly from Namibia and Zimbabwe. The inclusion of more reference samples, particularly from range states which are still under-represented in the database like Zambia, Kenya, Tanzania and Chad, will certainly also increase the predictive power of the model to finer spatial levels. Furthermore, the underlying statistical methodology compares isotopic fingerprints of elephant ranges. This mathematical procedure provides a tool for verifying the origin of ivory and can help to monitor both the legal and illegal trade of ivory along the market chain.

Concerning the chemical analyses the best results with the lowest false positive rate and the highest accuracy are achieved through the combination of all five stable isotopes (carbon, nitrogen, sulphur, oxygen, hydrogen), generating costs of about 450 US$. However, although the false positive rate for the combination of carbon, nitrogen and sulphur is slightly higher, analyses of these markers can be done at a rate of about 240 US$ which might be a cost efficient alternative without compromising the accuracy of the test. The analysis of just one isotope ration, sulphur, with costs of about 130 US$, is able to provide results with an accuracy of 84,8%.

The database is still in the progress of development and will be available via the world wide web as soon as possible (but not before 2014). We will inform the CITES member states in front of the official start. Besides others the corresponding link will definitely be published on the CITES web site of the FANC when accessible (www.bfn.de -> English -> CITES -> Useful Links).

4. Outlook

At the moment, the chemical analyses for the determination of the geographical origin of elephant ivory can solely be made at the Agroisolab in Jülich, Germany (www.agroisolab.de). In the following months the transferability of the method to other laboratories will be checked to be able to draw conclusions about the repeatability and accuracy of the isotope analyses. For this reason an interlaboratory comparison with facilities in several countries worldwide will be soon initiated, each applying their own devices and methods for the analyses, to ivory from the same tusk that will be provided in powdered and purified form. In cooperation with the International Atomic Energy Agency (IAEA) recommendations for the measurement of the stable isotopes of African elephant ivory will be

developed. For the enhancement of the reference database more georeferenced ivory samples have to be analysed and included into the database. Another further step to develop an overall working database could be the combination between the isotope method and the DNA-analysis by testing the same referenced samples. For this future financial challenge we are still searching additional funding for this project.

The existing database is generated by the database management system Microsoft Access and therefore can only be applied by persons experienced with this software. To make it available to a broad user group it will be modified to a user-friendly version. Every user will then be able to enter values of isotope analyses done in a laboratory in his own country in an entry mask and then see on a map the region where the ivory has probably had its origin (together with the accuracy in %), but also in tabular form. A demo-version of the future database has been made available on this USB-flash driver and a real time demonstration will be presented at a side event at the upcoming COP 16 in Bangkok.

The project will likely be concluded on December 31st, 2014.

5. Contact details

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