Europlanet TNA Report

PROJECT LEADER

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COLLABORATORS

Name:	**Affiliation:**
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Ashley Coutu	Research Associate, University of York (student)
Date of TNA visit:	30 Oct – 11 Nov; 13—22 Dec 2011
No. of days:	23 days in total, of which 17 in the lab
Host laboratory:	Vrije Universiteit Amsterdam
Reimbursed	xYes

Project Title – A bioarchaeological study of the changing East African ivory trade during the 19th century

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database)

The purpose of this project was to not only assess the range of $^{87}Sr/^{86}Sr$ values in archaeological and historic ivory traded out of East Africa during the 19th and early 20th centuries for provenancing, but also to develop methods of pre-treating these samples for more accurate $^{87}Sr/^{86}Sr$ results. This included a range of different pre-treatment washes prior to digestion on archaeological ivory samples, archaeological soil samples, and elephant tail hair samples. The purpose of this approach was to establish the most appropriate pre-treatment method for preparing these samples for analysis. The results from these samples show a large range in $^{87}Sr/^{86}Sr$ values characterising the diverse geology of the East African region. Interestingly, the archaeological ivory was likely from elephants locally sourced, while ivory traded to Europe later in the 19th and early 20th centuries were from elephants that once lived further inland in East Africa. Finally elephant tail hair results confirmed the potential use of $^{87}Sr/^{86}Sr$ analysis to track elephant movement over diverse geological boundaries.

Full Scientific Report on the outcome of your TNA visit

Approx. 1 page

This project sought to characterise three different groups of East African elephant samples using $^{87}Sr/^{86}Sr$ analysis: archaeological ivory, historic/traded ivory, and historic tail hairs. Coutu (2011) has previously established a baseline map of isotope values for East African elephants, so it was possible to use this baseline data as a way to then provenance the archaeological and historic ivory samples analysed at the Vrije Universiteit Amsterdam to specific regions in East Africa. The archaeological ivory samples consisted of material excavated from a rock shelter site likely dating to the 18th century in southeastern Kenya (Kusimba and Kusimba 2000) as well as ivory material found from a 19th century caravan trade halt in northeastern Tanzania (Biginagwa 2009). The historic ivory samples were primarily samples of cutlery handles and rule blanks that were purportedly made from East African elephant tusks shipped to England and then manufactured in Sheffield (northern England) in the late 19th and early 20th centuries. And finally the historic tail hair samples were from a big game hunting collection located in Kent, England, and were from East African elephants shot by Major Powell Cotton in the late 19th and early 20th centuries. Thus, the purpose of analysing the archaeological and historic material was to provenance these pieces to specific regions in East Africa, in order to then be able to add to the understanding of the archaeological sites, as well as the economy of elephant hunting and trade to Europe during this time period. The purpose of analysing the tail hair samples was to reveal whether the roaming behaviour within a single East African elephant is too diverse to be able to accurately provenance a incrementally growing tissue (hair, ivory) to a specific region in East Africa.

The other important purpose of this project was to establish the best protocols for digesting and analysing archaeological and historic elephant tissues, since ivory reacts differently than other types of bone material in the presence of certain acids (acetic acid, for example). Furthermore, there is currently no established method for the washing and digesting of elephant tail hair for radiogenic isotope analysis.

For the archaeological ivory, we first washed the ivory in weaker acids (HAc and $1MHNO_3$) and analysed this leachate in order to understand the composition of mobile Sr in the ivory (Figure 1). Then the ivory samples were digested in a stronger acid ($3MHNO_3$) which is the standard approach for digesting calcium carbonate in preparation for separation of Sr using column chemistry. For the archaeological ivory samples that were excavated in southeastern Kenya, the $^{87}Sr/^{86}Sr$ values of the washes were significantly different to the value for the residual ivory sample, suggesting that the mobile Sr is likely derived from the burial environment and the measurement of the residual sample is the biogenic Sr composition, incorporated when the elephant was alive and not due to post-depositional processes. Significantly, all of the ivory samples and washes were within the same geological range of Kenyan volcanics found in this region, from 0.707155 to 0.707990. The other archaeological sample found in northeastern Tanzania was also measured within this range, 0.707367, which again is not surprising as this area is dominantly volcanic and suggests that the elephant was killed locally. Within the group of historic ivory cutlery handles from Sheffield, England, most of these ivory pieces had quite high $^{87}Sr/^{86}Sr$ values (0.716-0.728). These values are significantly higher compared to the archaeological East African ivory. These values are more representative of elephants living in regions of

basement geology, and their light isotope values (carbon and nitrogen) confirm that this ivory was likely from elephants living in forested regions of East Africa with old geology such as the Precambrian basement found in parts of eastern Congo and western Uganda. This is a significant result, given that most of these pieces were manufactured quite late during the ivory trade, when historical sources note that the extraction of ivory at that time had moved almost completely into the interior regions because elephants along the coast and in the Rift Valley regions of East Africa had been 'hunted out' by this time (Håkansson 2004).

The tail hairs were treated like the archaeological ivory, washed first in a weaker acid (2MHNO_3) and this leachate was measured to identify the mobile Sr found in elephant hair (Figure 2). The results from the leachate and fully dissolved tail hair were interesting, as the leachate was consistently more highly concentrated in Sr (38-132 ppm) than the cleaned hairs (0.2-8 ppm). In all of the hair samples, the $^{87}Sr/^{86}Sr$ values of the leachate were significantly different (outside error of ±0.00001) than the values for the hair, and in all of the hairs the $^{87}Sr/^{86}Sr$ value of the leachate was lower than the hair $^{87}Sr/^{86}Sr$ value. This suggests that the pre-treatment is removing the mobile Sr binding to the outside of the hair shaft, which seems to be, at least for some of the tail hair samples, material such as soils or debris which has a significantly different $^{87}Sr/^{86}Sr$ value to that measured for the hair. So, this cleaning step is important. For some of the tail hairs where multiple samples were taken down the length of the hair, there is a large variation in the $^{87}Sr/^{86}Sr$ values. This is particularly noticeable in the tail hairs of elephants living in regions of highly diverse geological substrates, such as the Mt Elgon region of Kenya. Elephants in this region likely exploited resources on both young volcanic and old Precambrian basement, which is reflected in the range in $^{87}Sr/^{86}Sr$ values down the length of the hair. These changes in the hair are also reflected in the light isotope values on these same tail hairs (carbon, nitrogen, oxygen) and thus it is likely all of these isotope profiles are showing movement to a different habitat during the time that piece of tail hair was growing. Thus, there is more work that needs to be done on how Sr is actually incorporated in the body and then synthesised in keratin production through the growth of the tail hairs.

Overall, this project successfully utilised $^{87}Sr/^{86}Sr$ analysis as method of provenancing a range of East African elephant tissues. These data not only aid in answering archaeological and historical questions surrounding the origin and movement of ivory during the 18th – 20th centuries, but also sheds light on methodological questions about the growth and incorporation of Sr into elephant tissues. The large home ranges and movement of elephants can be seen in some of the tail hairs using $^{87}Sr/^{86}Sr$ analysis down the length of the hair, but more work is needed to fully understand the microstructure of elephant tail hair before this method can be routinely applied for tracking elephant migration habits. In collaboration with colleagues at the VU working on keratin, we will continue to analyse this problem of understanding how Sr is incorporated into the body and into keratin production. This will also be an important publication output of these results, in that there has been no other study published on the use of Sr in tail hairs to trace elephant migration. Ultimately, this project also continued to build the isotopic database of East African elephant ivory that is necessary for using this method as a way to trace the flow of elephant ivory out of East Africa from the colonial period to the present day. Thus these data from the archaeological and historic ivory will be included in publications incorporating the light isotope values from these pieces of ivory to discuss using multiple isotopic profiles for provenancing East African elephant ivory traded during the colonial

period.

Biginagwa, T.J. (2009) Excavation of 19th century caravan trade halts in north-eastern Tanzania: A preliminary report. *Nyame Akuma* 72, 52-60.

Coutu, A.N. (2011) 'Elephants, humans and ecology during the nineteenth century East African caravan trade: a bioarchaeological study', *Anitquity* Project Gallery 85 (327).

Håkansson, T. (2004) The human ecology of world systems in East Africa: the impact of the ivory trade. *Human Ecology* 32(5), 561-591.

Kusimba, C.M. and Kusimba, S.B. (2000) Hinterlands and cities: archaeological investigations of economy and trade in Tsavo, southeastern Kenya. *Nyame Akuma* 54, 13-24.

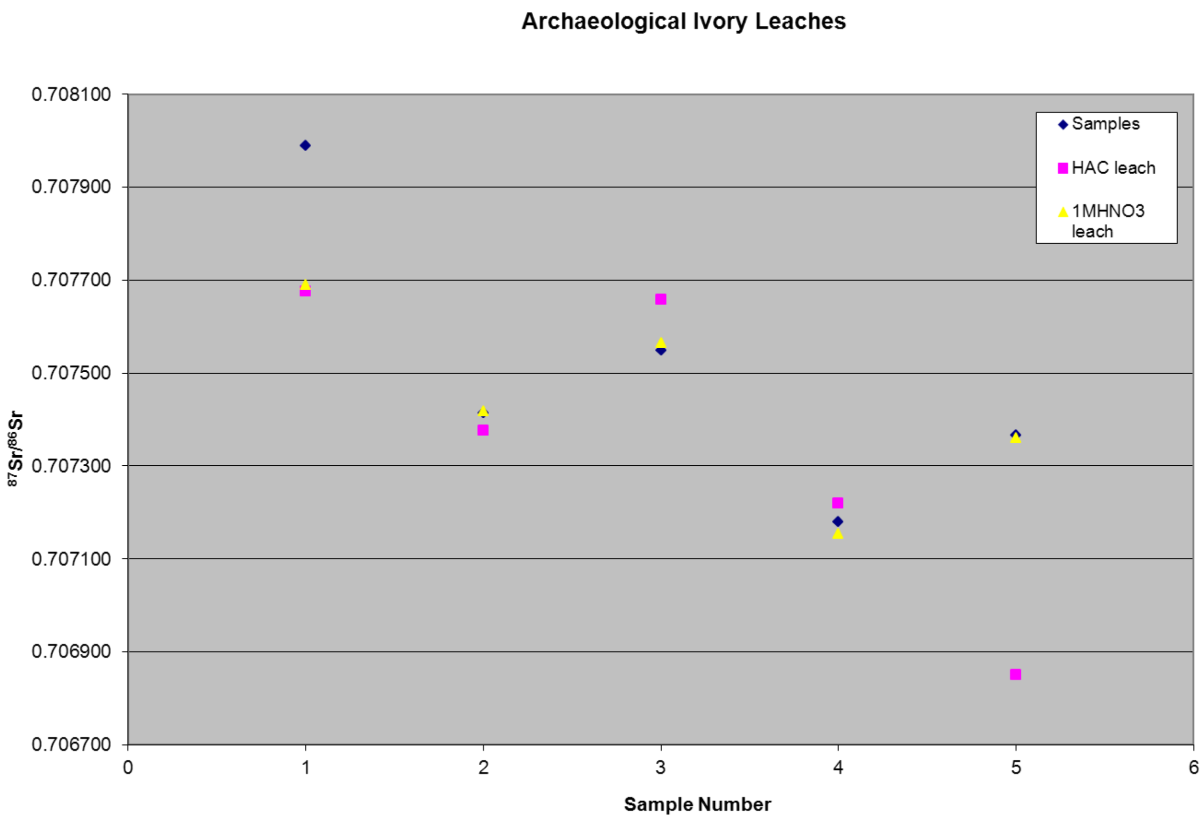

Figure 1 Each pink marker represents the $^{87}Sr/^{86}Sr$ measured in the initial acetic acid wash of the archaeological ivory sample, the blue marker represents the value measured on the leachate from the stronger 1M nitric acid wash of the ivory and finally the blue marker represents the value of the complete digestion of the ivory in 3M nitric acid.

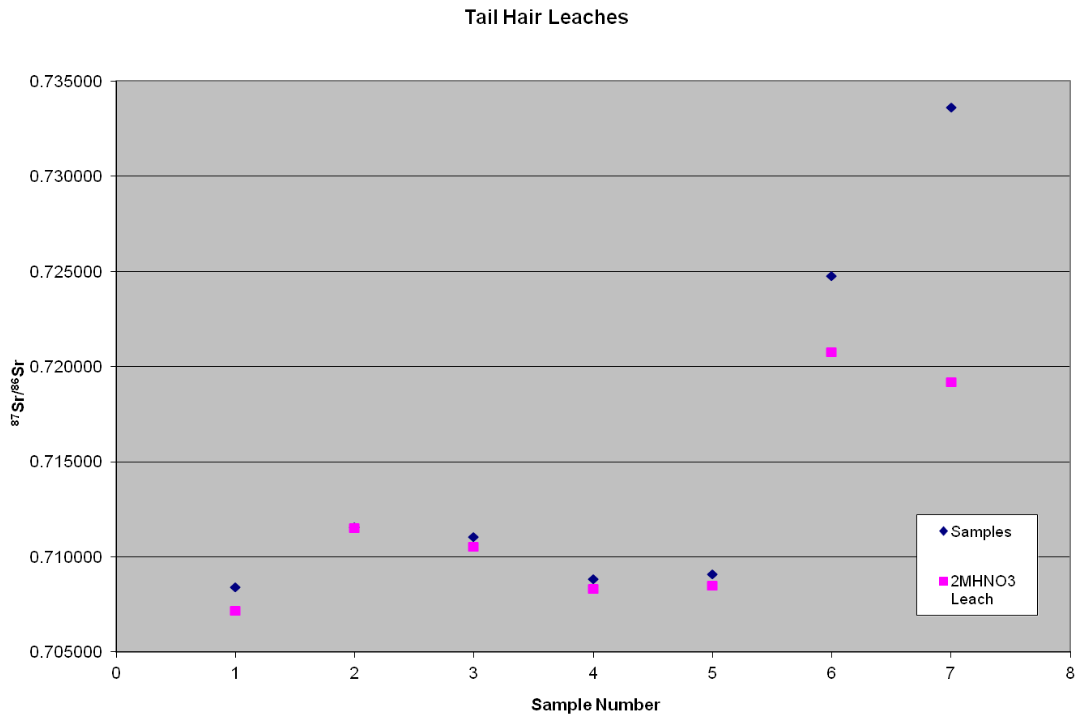

Figure 2 Each pink marker represents the $^{87}Sr/^{86}Sr$ measured in the initial 2M nitric acid wash of the tail hair, while the blue marker represents the value measured on the tail hair using a series of strong acids to fully dissolve the hair.

Please include:

- Publications arising/planned (include conference abstracts etc)

Because this project successfully highlighted the importance of a methodology to pre-treat archaeological ivory and elephant tail hairs, one planned publication will be in collaboration with colleagues at the VU to describe the results of the washes and the importance of the pre-treatment protocols in getting accurate $^{87}Sr/^{86}Sr$ results in the future from this material. This data will also be included in the multiple publications that will be output from the larger research project that Coutu has worked on for her PhD project on provenancing historic and modern elephant ivory from the East African region. The data created by this Europlanet project will be an important part of the larger data set of isotope values that will be published for elephants in this region in various journals, ranging from African wildlife ecology as well as African archaeology and history.

- Host approval

The host is required to approve the report agreeing it is an accurate account of the research performed.