**PERMIT APPLICATION DETAILS:**

**PERMIT FOR THE EXPORT OF CHARCOAL SAMPLES FROM KEH-1 FOR THE PURPOSE OF AMS DATING**

**Export/sampling permits**

Please note an export permit must be linked to an object or site that has to be created on SAHRIS! If the object/site you want to work on has not been created yet, you would need to do so. Thanks!

The proposal should include (you can fill these in below):

* a list of participants (name, affiliation, phone no, email addresses) and how they are involved;
* the name and address of the facility, including address, it is being scanned at;
* name and address of the museum/university department that currently hosts the object;
* names of the responsible person(s) during transport and while the fossil is at the facility;
* the period/time frame during which the fossil(s) will be outside the country;
* detailed information on the fossil(s), especially as it is a "unique" specimen;
* detailed information on the research project behind it & methodology including expected outcomes (i.e., the reason for export);
* the written confirmation of the institution that currently hosts the object that the object may be used as proposed and be returned in good condition;
* should there be any damage/destructive analysis (e.g., coating for higher resolution) undertaken, this needs to be stated in detail;
* Statement why this study cannot be done in South Africa.

**Applicant (name and affiliation): this is usually the museum curator!**

Dr. Thalassa Matthews

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**Applied for (principal researcher):**

Naomi Cleghorn, Ph.D.

Assistant Professor

University of Texas at Arlington

Arlington, Texas

USA

**Participants with affiliations, email addresses, phone numbers (& their role):**

1) Dr. Emma Loftus, Ph.D.  
Researcher  
Research Laboratory for Archaeology and the History of Art (RLAHA)  
University of Oxford  
Oxford OX1 3QY  
  
<http://users.ox.ac.uk/~mert2969/>

Email: Emma.Loftus@RLAHA.ox.ac.uk  
College Phone: 01865 272746

Role: Isotope expert analyst

2) Naomi Cleghorn

Associate Professor

University of Texas at Arlington

Arlington, Texas, USA

Email: [cleghorn@uta.edu](mailto:cleghorn@uta.edu)

Phone: +1-510-847-4190

Role: Archaeologist, Site Director

The material will be **shipped via FedEx or hand-carried** to the University of Oxford in July of 2017.

The material will be returned to the collection by July 31, 2018.

**Institution incl. address that currently hosts the object:**

Mossel Bay Archaeology Project CRM, Inc.

Munro House Laboratory

Diaz Museum

Mossel Bay, South Africa

Permission to remove the samples is attached.

**Facility incl. address at which the experiment will be done:**

Research Laboratory for Archaeology and the History of Art (RLAHA)  
University of Oxford  
Oxford OX1 3QY

UK

**Table of objects or upload file:**

**Turbo sarmaticus opercula from KEH Cave 1.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample Number | Lot | Strat Unit | Strat Aggregate | Weight (g) | Greatest Diameter (mm) |
| 13261 | 163 | K160 | UC | 2.2 | 20.95 |
| 13437 | 163 | K160 | UC | 8.4 | 35.00 |
| 12965 | 164 | K16L1 | UC | 9.7 | 34.61 |
| 12966 | 164 | K16L1 | UC | 6.9 | 26.06 |
| 13273 | 166 | k16I1 | UC | 11.5 | 39.16 |
| 13280 | 166 | k16I1 | UC | 5.5 | 31.12 |
| 13450B | 166 | k16I1 | UC | 5.1 | 28.97 |
| 28034 | 343 | K16FP | DHA/DS | 3.0 | 27.47 |
| 13335 | 162 | K16J1 | UC | 16.7 | 44.45 |
| 13302 | 162 | K16J1 | UC | 12.2 | 38.16 |
| 13336 | 162 | K16J1 | UC | 10.0 | 38.12 |

**Site including age at which object was found:**

Knysna Eastern Heads Cave 1 (KEH-1)

The excavated portion of this site has been dated to approximately 18 ka to > 46 ka.

**Time frame:**

Samples will be analyzed between August 2017 and August 2018.

**Aim/rationale:**

Much of the robust evidence for the early emergence of modern human behaviour, including consistent use of marine resources, in the African Middle Stone Age comes from a series of sites along the southern Cape coastline, South Africa. Both the nature of marine resource use and the climatic and environmental contexts of these sites from the Last Interglacial into Marine Isotope Stages 4 and 3 has been a long-standing focus of attention. During my doctoral studies (completed in Nov 2016), I constructed a seasonally-resolved record of Pleistocene and Holocene sea surface temperatures (SSTs) for the south coast of South Africa using oxygen isotope analyses of archaeological shells from sites including Nelson Bay Cave, Pinnacle Point 5-6 and Klasies River (Loftus, 2016; Loftus et al., submitted). However, none of these sites preserved shells from MIS3 aged deposits, leaving a crucial time gap in my record. The shells from Knysna Eastern Heads Cave 1 will help to fill this gap, and round out this seasonal climate record across the last glacial cycle. Most importantly, these samples will allow us to connect the records from the Middle and Later Stone Age sites, illuminating the cultural and economic changes that occurred across this key transition period.

**Methodology (short):** High resolution sampling for δ18O analysis is undertaken with a micromilling instrument mounted to a microscope, with each sample representing a relatively short period of growth (weeks to months). Each opercula will be sampled up to thirty times. Importantly, the path of the drilling path taken my will not preclude future attempts to sample these same shells by other researchers. The small powder samples are analysed using a Sercon CAPS carbonate device for carbon and oxygen isotope ratios, and the oxygen measurements can be interpreted, via well-established carbonate precipitation equations, to temperature measurements (Galimberti et al., 2017).

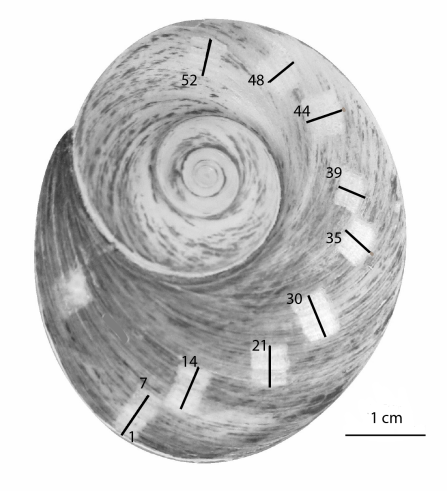


Figure showing a modern opercula microsampled more than 50 times (the numbers indicate the number of samples taken). Note the small amount of damage to the surface, and the preservation of the overall shell dimensions.

**Confirmation/permit by museum (**Attached):

See attached HWC permit number 3661 and letter of permission to remove specimens from the KEH-1 assemblage currently stored at the Diaz Museum, Mossel Bay, South Africa.

**Damage/destructive analysis? (if yes, explain in detail).** Yes – however, the micromill penetrates less than 1/10th of a mm into the surface of the operculum, and damage to the shell is minimal, at the surface only (see figure above). Importantly, the dimensions of each operculum (i.e. length) are not affected by this sampling method.

**Statement why this study cannot be done in South Africa:**

Three pieces of analytical equipment are essential for these analyses, and are not available to this project in South Africa. Firstly, the high-resolution, and very time-consuming, sampling protocol requires abundant time on a microscope-mounted micromill. One is available at the University of Oxford, in collaboration with the Department of Earth Sciences, with no charges levied. Secondly, each sample must be evaluated for recrystallization, using a method developed by Emma Loftus using an FTIR-ATR instrument at the Research Laboratory for Archaeology in Oxford (Loftus et al., 2015). Finally, a mass spectrometer with a carbonate device capable of measuring such small samples is not available in South Africa.

**References Cited:**

1. Galimberti M, Loftus E, Sealy JC .2017. Investigating δ18O of Turbo sarmaticus (L. 1758) as an indicator of sea surface temperatures. *Palaeogeogr Palaeoclimatol Palaeoecol*.
2. Loftus E (2016) Sea surface temperatures from oxygen isotopes in marine molluscs in Middle and Later Stone Age sites, South Africa. Dissertation (University of Oxford).
3. Loftus E, Rogers K, Lee-Thorp JA (2015) A simple method to establish calcite:aragonite ratios in archaeological mollusc shells. *J Quat Sci* 30(8):731–735.
4. Loftus E, Sealy J, Leng M, Lee-Thorp J. A late Quaternary record of seasonal sea surface temperatures off southern Africa. In review, *Quat Sci Rev*