Cotlow Award Application 2011
Department of Anthropology
The George Washington University
Washington, DC 20052

1. Personal Information

Applicant’s name: Heather Dingwall

Degree sought: B.S., B.A.

Field of study/major/minor/concentration: Biological Anthropology, Archaeology

Expected date of graduation: May 2012

Faculty advisor(s) (who have served as your mentor or mentors for this proposal): Dr. Brian G. Richmond

2. Language Skills

Does the proposed project involve the use of a “field language”? No

If yes, state what the language is and your degree of fluency in speaking, reading, and writing it:

3. Title of the Project and Abstract

Project Title: Analysis of *Homo erectus* fossil footprints from Ileret, Kenya in the context of unshod Daasanach experimental prints

Abstract of the Project (provide a summary description of the project’s goals, location, methods, and relevance to anthropology) [80 word maximum]:

Fossil footprints provide the only direct physical evidence of bipedal gait exhibited by extinct hominins. However, the paucity of information regarding the relationship between pedal anatomy, gait, speed, and footprint morphology limits the inferences paleoanthropologists can make from such evidence. This project aims to clarify this relationship through experiments with habitually unshod subjects in Ileret, Kenya. The ultimate goal of this research is to use the modern experimental data to better understand fossil footprints and the evolution of human gait. [80 words]

4. Description of the Project (describe your overall research goals, what the project is generally about, and where you will conduct the research and why) [250 word maximum]:


This project is a subset of a larger research project in Ileret, Kenya led by Dr. Brian Richmond. The main goals of the overarching project are to (1) determine the relationships between gait, speed, foot anatomy, and sediment properties and their effect on footprint formation in habitually unshod and shod people in order to improve functional inferences of fossil footprints, (2) examine the functional and anatomical significance of the *H. erectus* prints at Ileret and Koobi Fora, and (3) conduct further excavations to recover, scan, and document additional prints at known trackways. My portion of this larger project involves (1) examining key relationships between anatomy, gait, speed, and footprint shape in subadult habitually unshod Daasanach subjects from Ileret, Kenya, and (2) excavating new fossil footprints. Among other objectives, I will document the relationship between speed and stride length, which are derived from 2-D kinematic data captured on video, as well as the relationship between lengths of the experimental footprints and the subjects’ lower limb and body lengths (i.e., stature). Finally, I will help excavate new fossil hominin footprints at the FwJj14E site in Ileret (the longest footprint trail of seven prints continues directly into the unexcavated sediment, indicating a strong likelihood that further unexcavated prints remain to be found), and use the results of a regression analysis of my experimental data as a basis for the estimation of the stature and speed of the hominins responsible for the fossil footprints.

5. Significance of the Project to Anthropology (in this literature review describe how the proposed research relates to other anthropological research on the topic, and/or region as relevant; use American Anthropological Association style for works cited--no footnotes) [500 word maximum]:

Bipedal gait is one of the key adaptations that make humans unique. However, there are limited means of testing hypotheses about the evolution of human gait causing it to remain a hotly debated topic. Footprints provide the only direct physical evidence of hominin (humans and our extinct relatives) gait and foot function but are extremely rare in the fossil record. Until the recent discovery of two sets of possible *Homo erectus* footprints at the 1.5 million year-old (Ma) site of Ileret in Kenya by Dr. Richmond and his team (Bennett et al. 2009, image to left), there were only two known instances of early hominin footprints in the fossil record: the 3.7 Ma footprints at Laetoli (Leakey and Hay 1979) and the lesser-known and poorly-preserved set at Koobi Fora ca. 1.43 Ma (Behrensmeyer and LaPorte 1981). Recently, some (e.g., Meldrum et al. 2010) have raised questions about the conclusion by Bennett et al. (2009) that the 1.5 Ma Ileret footprints represent essentially modern pedal anatomy and gait. This new disagreement adds to decades of debate over the interpretation of the 3.7 Ma Laetoli footprints. While some researchers contend that the morphology of these prints suggests a more primitive gait and foot structure, such as a lack of a longitudinal arch and a big toe positioned away from the midline, exhibited by the associated hominins (Deloison 1991, 2004; Meldrum 2004; Bennett et al. 2009; Raichlen et al. 2008), others argue in favor of the presence of a more modern foot structure and an essentially modern gait (Leakey and Hay 1979; White 1980; White and Suwa 1987; Tuttle 1988; Schmid 2004; Ward et al., 2011).

Such disagreements have arisen largely because little is known about how foot shape influences the shape of footprints. Therefore, while the newly discovered fossilized prints at Ileret raise new questions regarding hominin foot anatomy and the evolution of human gait, more
must be learned regarding the relationship between footprint morphology, and foot anatomy and
gait characteristics in order to answer these questions. Furthermore, it is critical that these
questions be investigated with habitually barefoot subjects since the habitual use of shoes is
known to influence foot development and biomechanics (D’Août et al. 2009), and early
hominins at 1.5 Ma almost certainly lacked shoes— the earliest evidence of shoes dates to ca.
30,000 years (Trinkaus 2005), and the 1.5 Ma prints are distinctly barefoot prints.

The discovery of fossil footprints at Ileret dating to 1.5 Ma fills a critical gap between the
3.7 Ma prints at Laetoli and modern prints. The proposed excavations will likely unearth
additional footprints that would provide the best evidence to date about the evolution of
bipedalism at 1.5 Ma. The experimental work will provide comparative data needed to rigorously
interpret these footprint assemblages. Access to habitually unshod people (the Daasanach) and
technological advances (e.g., 3D scanning) now allow us to collect these data and make more
robust interpretations about foot shape, stature, speed, and eventually gait characteristics
throughout human evolution.

6. Methods (clearly outline or list your research questions; describe the data you will collect and
how you will collect it; discuss your analytical methods; and show how the data will address the
research questions) [300 word maximum]:

Controlled experiments will be conducted in the field in July 2011 to determine the relationships
between gait, walking speed, and foot anatomy and how these variables affect the morphology of
footprints, specifically in subadults. I am focusing on subadults for this project in an effort to
provide context for the smaller fossil prints found in the Ileret trackways. Subjects will make
footprints at six speeds (stand, slow walk, preferred walk, fast walk, jog, and run) on sediment
taken directly from the fossil footprint layer and moistened. Habitually unshod Daasanach
children and subadults, ranging in age from 4 to 18 years (n=20), will be recruited from the local
villages. The following data will be collected for each subject: foot length, lower limb length,
stature, weight, age, and sex. 2D kinematic data will be recorded with a video camera set
perpendicular to travel to be later analyzed to derive speed, stride length, etc. using Peak Motus
in Dr. Richmond's lab. The resulting footprints will be 3D scanned using photogrammetry
techniques after each trial; images and three-dimensional scans of the subjects’ feet will be made
as well for other components of the larger project. Excavations will be conducted using
established methods (e.g., fine-brush technique), and the footprint surface will be 3D scanned.
Linear regression methods will be used to analyze the experimental data in order to test
hypotheses about the relationships between age, stature, lower limb length, weight, sex, speed,
stride length, footprint length, and other variables. These relationships will be used to generate
predictions, with associated confidence limits, regarding the speed, stature, and size and age of
the individuals who made the 1.5 Ma footprints at the Ileret site we excavate.

7. Research Ethics (describe how you will ensure that your research project is conducted in
accordance with anthropology guidelines and the guidelines of your particular field within
anthropology, and in the case of “Human Subjects Research,” according to the criteria of GW’s
Institutional Review Board. For the former, consult the Web site of the American Anthropologi-
cal Association (http://www.aaanet.org). For the latter, discuss requirements with your faculty
mentor and/or with Professor Barbara Miller, the IRB rep in the Anthropology Department. Most student projects involving living humans fit in the IRB category of “excluded” meaning that IRB forms do not need to be submitted, if they follow AAA ethical guidelines in terms of informed consent and avoidance of harm to participants, do not involve medical topics and do not identify particular individuals. In some instances, IRB approval does need to be sought, usually in the “expedited” category.” Information on these categories is also available at http://www.gwumc.edu/research/human/aboutus/html [150 word maximum]:

This project will be conducted in accordance with the guidelines of the George Washington University’s Institutional Review Board for experiments on human subjects as well as with the American Association of Physical Anthropology Code of Ethics. IRB approval was given to the experiments conducted last year (GWU IRB#031030); this approval is in the process of renewal for this year’s project. The subjects’ identities will remain confidential and we will gain their signed consent, as well as that of their parents or guardians, prior to beginning experiments. All subjects will be made aware of any risks associated with the experiments. All excavations will be conducted carefully and documented systematically to ensure the preservation of the footprint trackways, in consultation with the Directors of Archeology and Earth Sciences at the National Museum of Kenya.

[132 words]

8. Research Product (discuss how you will use and present your findings including, for example, a presentation at a professional meeting, a film, a museum exhibit, a publishable paper, a thesis) [150 words maximum]:

Last year, as a George Gamow undergraduate research fellow, I conducted field experiments using adult Daasanach subjects. The resulting data have already proven useful in providing improved stature and speed estimations of the known Ileret footprints; I am lead author on an abstract accepted for publication in the journal PaleoAnthropology, for my presentation of these results at the April 2011 Meeting of the Paleoanthropology Society. In conjunction with my prior research, this project will form the bases of my honors senior thesis in Biological Anthropology and a lead-author abstract submitted for the 2012 Meeting of the American Association of Physical Anthropologists. As lead author, I will also submit my honors thesis for publication in a peer-reviewed journal (e.g., American Journal of Physical Anthropology). Additionally, my results will contribute to other fossil footprint research by Dr. Richmond and colleagues, including the oldest known modern human footprints at Engare Sero, Tanzania. [149 words]

9. Timetable (briefly describe the schedule of your research activities week-by-week or as appropriate):

Mid-June – July 2011: Fieldwork (experiments and excavation) in Ileret, Kenya.

Fall 2011: Lab analysis of the results of the field experiments. Composition and submission of abstract to the AAPA for presentation in the spring. Primary drafting of honors senior thesis.

April 2012: Poster presentation at AAPA meeting.
10. Budget Amount and Projected Expenditures

Total Amount Requested: $1965

Projected Expenditures (list the expenditure categories for your project, for example, transportation--international, domestic, local; room and board; and research supplies). Funds from a Cotlow award cannot be used for tuition, academic fees, or for purchasing equipments such as a laptop or camera [awards range from a few hundred dollars to $1800]

Round-trip airfare between the United States and Nairobi, Kenya: $1800
Living stipend for time spent in Nairobi (two nights before travel to Ileret): $25 visa entry fee; $140, 2 days at $70 per day

11. Staff (if others are to participate in the project as researchers or research assistants, please give their name and qualifications):

Dr. Brian G. Richmond, Department Chair and Assistant Professor, Center for the Advanced Study of Hominid Paleobiology, GWU Anthropology Department

Kevin G. Hatala, Doctoral Candidate, Center for the Advanced Study of Hominid Paleobiology, GWU Anthropology Department

12. Outside Financial Support (list any other sources of funding for the project, either obtained or applied for, with amounts and restrictions):

I applied for, and have been awarded, a GWU Luther Rice Fellowship ($5000). However, the monetary award is not dispensed until July 1, 2011, after we are in the field. Therefore, this award will be used to cover costs during the week in Nairobi processing data, and to return to the field to continue this research in June, 2012.

13. References Cited/Select Bibliography (list the sources you have cited in the proposal and/or used as background research. Use the style defined by the American Anthropological Association [see http://aaanet.org]; list a minimum of 10 sources cited to a maximum of one page; more than 10 references are expected in proposals submitted by MA and PhD students).

D’Août, K., T.C. Pataky, D. De Clerq, and P. Aerts.
Leakey, M.D. and R.L. Hay

14. Permits (demonstrate that you have, or are seeking, any necessary permits such as a research permit, a research visa, an antiquities permit, letter of welcome from an institution, etc. Attach copies to this proposal).

This research is conducted under the MOU between the National Museums of Kenya with Rutgers University and GW.

15. Transcript (submit a copy of your transcript with this proposal; it can be either official or unofficial. Without a transcript, your proposal is incomplete and will not be considered).