Final Report

"Fossil Birds: Strengthening Hominin Land Use Models at Olduvai"

Kari Alyssa Prassack, Ph.D. candidate

Center for Human Evolutionary Studies, Rutgers University, 131 George Street New Brunswick New Jersey 08901 USA

The goal of this dissertation project was to determine the relevance of fossil bird occurrences for understanding Pliocene hominin habitats. This was tested using Plio-Pleistocene bird assemblages from Bed I and Lowermost Bed II at Olduvai Gorge, Tanzania. The majority of these fossils come from excavations (1989-2008) that were made by the Olduvai Landscape Paleoanthropology Project (OLAPP). One Leakey assemblage, from Level 3 at the Lower Bed I site of DK, was also included in this study.

This was the first systematic and comprehensive analysis of a fossil bird assemblage to combine taxonomic identifications with extensive, first hand, neo-taphonomic and ecologic data derived from studies in modern analogue landscapes. This work was designed to test (using avifaunal data) the validity of previous hominin land use and paleolandscape reconstructions, including the potential impact of landscape structure on hominin foraging and routing strategies, by identifying finer-grain changes in habitat across these landscapes.

The goals of this study were met, as can be seen in the list of presentations, publications and "in preparation" manuscripts (grantees name is bolded in citations for easy reference). Data presented here is limited due to the sensitive nature of these deposits (see Dalton 2007) and pending publications of such data elsewhere (i.e. Prassack 2011, Prassack in prep a, b and c; Blumenschine et al. 2011, in revision).

This work would not have been possible without the generous support of the Leakey Foundation. I would like to thank the committee for granting me the funding necessary to conduct this analysis and for believing in my ability to learn avian osteology and successfully analyze these fossil birds.

Methodology

The Olduvai Landscape Paleoanthropology Project (OLAPP) utilizes a landscape paleoanthropology approach to their excavations. In using this method, numerous, relatively small-scale excavations are placed across exposed portions of the Olduvai Basin. Overall, recovered artifacts for a given trench can be small, but this method produces samples of stone tools, fossils, and other paleoenvironmental indicators across a full range of paleolandscape facets. This allows for a better understanding of hominin activities, as they would have occurred across the landscape.

Birds from the OLAPP excavations therefore come from a range of potential habitats. In some deposits their numbers are too few for quantitative assessment of their significance, but the identity of specific taxa, even a single individual at a trench, can allow both for a better understanding of the local environment as well as provide important data on avian evolution and ecology during the Pliocene.

Bird bones were primarily recovered from the excavated matrix using 5mm sieves. In some instances matrix was brought back to camp where it was wet-dry sieved. When possible, recent breaks were identified and glued. Rather than label bones with India ink, each bone identifiable beyond that of Aves received its own identification card and separate bag. This was done because ink can obscure diagnostic marks, both osteological and taphonomic.

The taxonomic analysis of these birds was originally to take place at the National Museums of Kenya, in Nairobi. However, it was determined that the Florida Museum of Natural History (FLMNH) collections were more extensive and, importantly, that an established expert of fossil birds (David Steadman) was available to act as a mentor for this grantee in her work.

Taxonomic identifications are conservative and based on comparisons to multiple modern specimens housed at the Florida Museum of Natural History (FLMN), and later those at the American Museum of Natural History (AMNH). During excavation, none of the specimens were found articulated, nor were any recovered in direct association with another bird bone. As such, less diagnostic elements such as phalanges, vertebrae, and sternal fragments were not assigned beyond Aves. The taxonomic term c.f. (confer) was used in cases where variability in osteological features is consistent with that of modern

representatives for that taxon. Sp. aff. (species affinis) was used where the name of a modern taxa is used to describe a specimen that shows strong affinity to, but for whom no modern equivalent has been identified, either due to its absence in the comparative collections or it being a yet to be described, extinct, but closely related, form.

Synopsis of the Olduvai Birds

Of the entire collection (>2,000 NISP), approximately 400 specimens could be identified to family level or higher (~100 are from Leakey DK, Level 3). There are at least thirty-three genera representing fifteen families. Shore (plovers, sandpipers), lake (ducks, grebes, cormorants), and wetland (rails, heron, flamingo) birds dominate (e.g., Prassack 2010b, 2011a, b and c, in prep a and b). Such taxa can have especially narrow habitat and dietary tolerances (Cheneval 1989; Rasmussen et al. 1987). They are often affected by local ecological stresses rather than larger scale changes; which means that they may better reflect the habitat in which they are found (Owino et al. 2001). These traits can make water birds (i.e. associated with lake and wetland systems) excellent environmental indicators. Importantly, the majority of Olduvai avian specimens can be attributed to modern forms, making them more reliable indicators of local habitats across these Plio-Pleistocene landscapes at Olduvai than occurs when dealing with more ancient, extinct taxa (Lawrence 1971; Rasmussen et al. 1987).

Ecological information for these birds paleolandscape distributions were applied to current Olduvai landscape models developed by OLAPP researchers (e.g., Deocampo et al. 2002; Bamford et al. 2006; Copeland 2007; Stolhnhofen et al. 2008; Blumenschine et al. 2011a,b), regarding the distribution of hominin affordances such as potable water, vegetative cover, and refuge trees (*sensu* Blumenschine and Peters 1998). The birds support previous reconstructions but also, importantly, provide a finer scale resolution of the types of habitats and their distributions across the paleolandscape.

Bed I Fossil Birds

Bed I has produced sizeable avifaunal remains for paleoecological and environmental analyses from Middle and Upper Bed I in the FLK Complex and the Lower Bed I deposits at DK.

FLK, Middle and Upper Bed I (1.845 ± 0.002 to 1.839 ± 0.005 Ma)

The taxonomic composition and taphonomic profiles of fossil birds from the FLK Complex were used to help to reconstruct the *Zinjanthropus* paleolandscape (i.e., equivalent to the Leakey's Level 22 at FLK and Level 1 at FLKNN). Specifics on these birds can be found in several peer-reviewed publications (Prassack 2010b; Prassack 2011b; Blumenschine et al. 2011a). The ecologic and environmental utility of fossil birds from the Olduvai Hominin (OH) 7 paleolandscape (i.e., equivalent to the Leakey's FLKNN Level 3) are discussed in Blumenschine et al. (in revision).

DK, Lower Bed I (~1.87Ma)

These birds come from the oldest archaeological level at DK (Level 3). They were collected during excavations made by the Leakey's (Leakey 1971) and were originally thought lost, part of the large fossil avifaunal collection that is now in the possession of Diana Matthiesen, a former graduate student at the University of Florida. In 2007, Michael Pante, who worked on the Leakey's Bed III material (2010, Ph.D. dissertation), discovered these fossils in one of the old buildings at the Leakey Camp, Olduvai. They were in an unmarked, deteriorated and rat-infested, cardboard box, with paper labels inside the bags denoting their source. No other DK material was found in the building. I recovered the fossil birds and properly conserved, analyzed, and catalogued them.

Data on the DK birds have never been fully published, although there is mention of the cormorants in Brodkorb and Mourer-Chauviré (1984). The DK assemblage has thus far been the basis of two talks, one where I applied modern neotaphonomic models to it (Prassack 2008) and more recently, where its taxonomy and taphonomy are used to help reconstruct this Lower Bed I environment (Prassack 2011c). This combined work will be part of a forthcoming manuscript (Prassack in prep b).

Lowermost Bed II Fossil Birds

Much of OLAPP's focus has been on reconstructing the paleolandscape of Olduvai during Lowermost Bed II (~1.75 Ma). The "landscape archaeology" methods utilized by OLAPP recovered fossil birds from numerous trenches across an area of ~

3km from the lake eastward. This allowed for expansive, horizontal, spatial correlation of the avian community composition and distribution across the paleolandscape, over a geologically short time frame (~50,000 years). These birds provide a finer scale correlation of hominin land use across time and space during the early Pleistocene of East Africa. This includes evidence that extensive wetland features dominated much of the Eastern Lake Margin, but that suitable roosting trees (i.e. safety trees for hominins, *sensu* Blumenschine and Peters 1998) were present. The taxonomic composition of these birds and their utility for understanding the LMBII paleolandscape was presented at the American Association for Physical Anthropology meetings (Prassack 2011a) and can be found in a forthcoming manuscript that will be submitted later this fall (Prassack in prep b).

Broader Application of These Data

This works provides new information for the study of avian systematics and taxonomy, by increasing the geographic and geologic range of several avian taxa for a period in Africa when few avian remains have been studied. The Plio-Pleistocene was a pivotal time in avian evolution; modern genera were established and with it, evidence of ecotypic behavior that is analogous to present day forms. It provides an important intermediary link between the older Neogene and more recent African avifauna.

Tanzania lies between the southern Afrotropical and Palearctic biota, making Olduvai of great interest to understanding migration patterns and ornithogeography throughout Africa. East Africa is a homing point for many Palearctic migrant birds (as many as 40% of the avian population) that come down from Europe during the cold months (Faaborg 1988). At Olduvai, there is definitive evidence of established Palearctic migration, as well as evidence that some taxa had a wider distribution during the Plio-Pleistocene than is seen today (Prassack in prep c).

Evidence of migration (presence of Palearctic taxa) and breeding (medullary bone in brooding females), can be used to address larger scale climatic patterns (Brodkorb 1985; Emslie et al. 1998), and hominin seasonal-based subsistence strategies (Avery and Underhill 1986; Simmons and Nadel 1998). This further supports the use of avian taxa in,

and their use as strong proxies for, recognizing spatially or temporally specific paleoenvironmental variables.

Concluding Remarks

My dissertation used the spatial and temporal distribution of birds and patterns of their bone survivorship across the paleolandscape to test and replicate predictions of landscape heterogeneity and construct brought forth by OLAPP's long-term interdisciplinary research. By doing so, it has greatly increased the validity of these models and strengthens our understanding of the types of environments utilized by our early ancestors. It is my hope that this work spurs addition focus on the role of fossil avifauna as important data sets in the study of hominin behavioral ecology and evolution.

References (grantee's name is in bold)

Avery, G., and L. G. Underhill. 1986. Seasonal exploitation of seabirds by late Holocene coastal foragers: analysis of modern and archaeological data from the Western Cape, South Africa. Journal of Archaeological Science 13: 339-360.

Bamford, M. K., R. M. Albert, and D. Cabanes. 2006. Plio-Pleistocene macroplant fossil remains and phytoliths from Lowermost Bed II in the eastern paleolake margin of Olduvai Gorge, Tanzania. Quaternary International 148: 95-112

Blumenschine, R. J., and C. R. Peters. 1998. Archaeological predictions for hominid land use during the paleo-Olduvai Basin, Tanzania, during lowermost Bed II times. Journal of Human Evolution 34: 565-607.

Blumenschine, R. J., I. G. Stanistreet, J.K. Njau, M. K. Bamford, F. T.Masao, R. A. Albert, H. Stollhofen, P. Andrews, K. A. **Prassack**, L. J. McHenry, Y. Fernández-Jalvo, E. L. Camilli, and J. I. Ebert. 2011, a. Environments and activity traces of Oldowan hominins across the FLK Peninsula during *Zinjanthropus* times (1.84 Ma), Olduvai Gorge, Tanzania. Fifty Years after *Zinjanthropus*: Landscape Paleoanthropology of Plio-Pleistocene Olduvai Gorge, Tanzania. Journal of Human Evolution (special issue).

Blumenschine, R.J., J. K. Njau, I. G. Stanistreet, M. K. Bamford, F. T. Masao, H. Stollhofen, R. M. Albert, P. Andrew, C. A. Brochu, K. A. **Prassack**, D. W.

Steadman, L. J. McHenry, Y. Fernandez-Jalvo, and J. I. Ebert. In revision. Early hominin predation risk from crocodiles and mammalian carnivores at Olduvai Gorge.

Brodkorb, P. 1985. Preliminary report on Pliocene Pleistocene birds of East Africa. Pp. 174-177 In, V. D. Ilyichev and V. M. Gavrilov, (eds.) Proceedings of the 18th International Ornithological Congress, Moscow.

Brodkorb, P., and C. Mourer-Chauviré. 1984. A new species of cormorant (Aves: Phalacrocoracidae) from the Pleistocene of Olduvai Gorge, Tanzania. Geobios 17(3): 331-339.

Cheneval, J. 1989. Fossil bird study, and paleoecological and paleoenvironmental consequences: examples from the Saint-gerandle-Puy deposits (lower Miocene, Allier, France). Paleogeography, Paleoclimatology, Paleoecology 73: 395-309.

Copeland, S. R. 2007. Vegetation and plant food reconstructions for lowermost Bed II, Olduvai Gorge, using modern analogues. Journal of Human Evolution 53(2): 146-175.

Dalton, R. 2007. War of words erupts over fossil dig. Nature 448:7149.

Deocampo, D. M., R. J. Blumenschine, and G. M. Ashley. 2002. Wetland diagenesis and traces of early hominids, Olduvai Gorge, Tanzania. Quaternary Research 57: 271-281.

Emslie, S. D., W. Frase, R. C. Smith, and W. Walker. 1998. Abandoned penguin colonies and environmental change in the Palmer Station area, Anvers Island, Antarctic Peninsula. Antarctic Science 10: 257-268.

Faaborg, J. 1988. Ornithology an Ecological Approach. Prentice Hall.

Lawrence, D.R. 1971. The nature and structure of paleoecology. Journal of Paleontology 45: 593-607.

Leakey, M. D. 1971. Olduvai Gorge, Vol. 3. Cambridge University Press.

Owino, A. O., J. O. Oyugai, O. O. Nasirwa, and L. A. Bennun. 2001. Patterns of variation in waterbird numbers on four Rift Valley lakes in Kenya, 1991-1999 Hydrobiologia 458: 45-53.

Pante, M. 2010. The larger mammal fossil assemblages from Beds III and IV, Olduvai Gorge, Tanzania: implications for the feeding behavior of Homo erectus. Ph.D. dissertation, Rutgers University.

Prassack, K.A. 2008. Using neotaphonomic observations to understand Plio-Pleistocene fossil bird bone assemblages at Olduvai Gorge, Tanzania. 7th Meeting of the Society of Avian Paleontology and Evolution, Sydney, Australia.

Prassack, K.A. 2010a. Late Pliocene avifauna from the *Zinjanthropus* land surface at Olduvai Gorge, Tanzania. 19th Meeting of the Paleoanthropological Society, St. Louis, Missouri.

Prassack, K.A. 2010b. Late Pliocene avifauna from the hominid-bearing *Zinjanthropus* land surface at Olduvai Gorge, Tanzania. In Proceedings of the VII International Meeting of the Society of Avian Paleontology and Evolution, ed. W.E. Boles and T.H. Worthy. Records of the Australian Museum 62(1): 185-192.

Prassack, K.A. 2011a. Fossil water and marsh birds as paleoenvironmental indicators, at Olduvai Gorge. 70th Meeting of the American Association of Physical Anthropologists, Minneapolis, Minnesota.

Prassack, K.A. 2011b. The effect of weathering on bird bone survivorship in modern and fossil saline-alkaline lake environments. Paleobiology 37(4): 633-654.

Prassack, K.A. 2011c. Avian taphonomy and Taxonomy at DK (Level 3), Middle Bed I site at Olduvai Gorge, Tanzania. 3rd Meeting of the East African Association for Paleoanthropology and Paleontology, Addis Ababa, Ethiopia.

Prassack, K.A. In preparation, a. Late Pliocene water birds from Lowermost Bed II, Olduvai Gorge, Tanzania.

Prassack, K.A. In preparation, b. The earliest hominin environments at Olduvai Gorge (site of DK, Level 3), based on avifaunal remains.

Prassack, K.A. In preparation, c. Evidence for Paleartic migration and broader range distributions for several avian taxa during the Pliocene of East Africa.

Rasmussen, D. T., S. L. Olson, and E. L. Simons. 1987. Fossil birds from the Oligocene Jebel Qatrani Formation, Fayum Province, Egypt. Smithsonian Contributions to Paleobiology 62: 1-20.

Simmons, T., and D. Nadel. 1998. The avifauna of the Early Epipaleolithic site of Ohalo II (19,400 years BP), Israel: species diversity, habitat and seasonality. International Journal of Osteoarchaeology 8: 79-96.

Stollhofen H., I. G. Stanistreet, L. J. McHenry, G. F. Mollel, R. J. Blumenschine, and F. T. Masao. 2008. Fingerprinting facies of the Tuff IF marker, with implications for early hominin palaeoecology, Olduvai Gorge, Tanzania. Paleogeography, Paleoclimatology Paleoecology 259: 382-409