Podcast interview: Clayton R. Magill, and Katherine H. Freeman

PNAS: I’m Sandeep Ravindran and welcome back to Science Sessions. Today you’ll be listening to Clayton Magill and Kate Freeman, who along with co-author Gail Ashley won the 2012 PNAS Cozzarelli Prize in physical and mathematical sciences. The prize recognizes their PNAS paper about the influence of water availability and ecosystem changes on early human habitats. Lack of clear records have made it difficult to study the environment in which early humans lived, and the researchers used isotope compositions preserved in ancient lake sediments to present a continuous record of water availability from about 2 million years ago. Magill starts by describing how he became interested in studying early human habitats.

Magill: Dr. Freeman’s been interested in understanding the dynamics of carbon cycling and water cycling in ancient environments for quite a while, and whenever I started working with her, the opportunity arose to look at carbon and water cycling at a hominin or an early human archaeological site in East Africa, called Olduvai Gorge. We were fortunate to have sediments that spanned between about 1.9 and 1.7 million years ago. The samples are associated with the emergence of direct ancestors of modern Homo sapiens, so Homo erectus. It’s also associated with an interval of time in which there’s major technological and cultural changes in early humans, as well as changes in social systems. So it’s interesting because different hypotheses of why, how, and when early humans changed into what we are now, focuses on this small time period from which we had samples. So it was a very complementary set of data to understand those changes and what may have driven them, or what’s consequence to them.

PNAS: What are the challenges in studying early human habitats?

Magill: One of the problems of course is a lack of modern analogs. The other issue of course is scaling and sample availability. So we have to think about the resolution that we’re getting from the samples that we’re looking at. If we know an entire landscape looked like something what does that actually mean on a small spatial scale that an early human would occupy.

PNAS: How did your study overcome these challenges?

Magill: We looked at relationships between plants and the types of habitats that they’re associated with in the modern day, and made a function that transfers isotropic values to ecosystems. So we say, we have a measurement, an isotope ratio, that reflects the amount of woody cover for instance in the modern landscape and probably in the ancient landscape. We use a similar approach to back out the amount of grassy cover. And we can use each of these ecosystem features to scale what the entire cachement would have looked like on average. And we can say, on average, an early human within this cachement would have experienced these kinds of conditions.
PNAS: What did you find?

Magill: What we found was that water availability in the landscape changed very rapidly, and quite frequently, given the generation time and the small window of geologic time we were looking at. And this landscape we were looking, at least as evidenced by organic matter preserved in lake sediments, shifted between a closed forest, so something with a canopy above and shade below, to an open grassland where you’re being beaten by the sun all day long. These shifts happened over just several hundreds to thousands of years, and not only did the plants change, water changed with them, and in a very real sense guided the plant changes. One thing that I think’s really interesting about this work is the importance of linking plant community changes to hydrologic changes. We can then explicitly address hypotheses of hominin evolution, because, many of these hypotheses depend intimately on the types of environments that humans occupy.

PNAS: What do you plan to study next?

Magill: We’ve recently been working on extending our work from a temporal scale to a spatial scale, and thinking about a single horizon associated with archaeological remains, and how over hundreds of meters or kilometers squared, the habitat these hominins were occupying was variable.

PNAS: Kate Freeman describes the next step in her research

Freeman: The other piece that I’m expanding on is looking for evidence of fire in the ancient landscape through time and space. And it’s interesting because fire is intimately linked into the ecology of the grasses. So I’m interested in it from that perspective. But there’s also ideas that with the rise of Homo erectus there is also the rise of humans controlling fire, and manipulating it either for hunting purposes, or possibly for cooking, there’s some hypotheses that the first cooked dinners were about this time period, so we’re really interested to see if we can see a signal.

PNAS: The Cozzarelli prize is awarded annually by PNAS to acknowledge recently published papers that reflect scientific excellence and originality. You can find more Science Sessions podcasts at PNAS.org.