MOLECULAR ARCHEOLOGY PUTS ARTIFACTS IN PERSPECTIVE

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Buried inside the Earth, lay secrets. Archeologists piece together histories often lost to time as they unearth human remains and their long-lost possessions.

Where archeologists exhume secrets from the soil, molecular archeologists uncover secrets lying inside human remains. By piecing together ancient DNA, molecular archeologists can more definitively answer questions about our past.

“Some people in my field consider themselves to be molecular archaeologists as we tend to work with archaeological remains and use an archeological context to help infer the genetic patterns we see,” said Ripan Malhi, an associate professor of anthropology at the University of Illinois and affiliate of the Institute for Genomic Biology (IGB).

While the day-to-day rigor of being a professor may not seem illustrious, over the course of the year, Malhi’s lab makes amazing discoveries.

Ripan Malhi is a molecular archeologist at the University of Illinois. Photo by Brian Stauffer. ©

The Golden Era of ancient DNA

“We can do things now that we haven’t been able to do before,” Malhi said. “I like to say that ancient DNA is in a golden era. When I was a graduate student working on ancient DNA, it probably would’ve taken me years to sequence one complete mitochondrial genome and now we can do that in a week or so.”

Today Malhi’s lab studies complete genomes as well as DNA passed down from mothers to their offspring (called mitochondrial DNA) and from fathers to their offspring (called the y chromosome) to infer the evolutionary history of populations and species. Currently, research in the lab is split into two research areas: the evolutionary history of Native Americans and evolutionary genetics of non-human primates.

Last year, his lab found an ancestral link between ancient remains and their living descendants.

“The community members were really happy about the results because their oral histories have said that they’ve been there for a very long period of time as well,” Malhi said. “Now through scientific and DNA data we are able to show this connection in a different way. Being able to show that connection with something that they’ve known to be true was really satisfying.”

While most archeology doesn’t include DNA analyses, they can be vital to distinguish cultural processes from biological processes, Malhi said.

In the past, movement of arrowheads or pottery from one region to another indicated that a population might have moved. But in reality, Malhi said, a number of other factors could explain the distribution of artifacts.

“By combining DNA evidence with this cultural data we can distinguish whether people are moving or cultural artifacts are being traded from one community to the next,” Malhi said. “Using DNA evidence, we can show how genetic variants moved across the geographic landscape after neighboring groups intermarried.”

This work does more than solidify community backgrounds and establish migration patterns. It can also illustrate evolutionary process and show us how we may evolve with other organisms. One of Malhi’s students is studying how infectious diseases brought over after European contact affected Native Americans’ genomes.

How molecular archeology works

First, Malhi works with Native American communities to find out what questions they would like to answer. It’s a first step that scientists have often skipped in the past.

“They know their own history better than I’ll ever know it,” Malhi said. “They can look at the genetic patterns and give us ideas about what those patterns may represent.”

Malhi interacts with Native American communities and museum curators to discuss what the community members hope to learn from DNA analysis, the questions he wants to address, and how best to extract DNA from the ancestral remains.

Next Malhi visits the communities or museums to pick up the remains. Sometimes he has the chance to be onsite during the excavation as the archeologists collect the remains with gloved hands to prevent modern DNA contamination, from their skin cells and microbiome.

At Malhi’s lab, the remains undergo a surface decontamination to ensure that modern DNA is not included in the final analysis. Then they drill out a sample about the size of a cavity from the bone or tooth. The sample is ground up to a fine dust then sequenced and analyzed.

Finally Malhi is able to look for genetic patterns by combining the new results with published results from various databases and combines that information with other anthropological information, such as the community’s oral histories or cultural artifacts from the archeological site.

Today molecular anthropologists like Malhi can turn DNA fragments that are only around 200 or so base pairs in length into a complete human genome made up of about three billion base pairs.

It’s more than a job

From interacting with Native American communities to seeing his students begin successful careers, Malhi said his job is really satisfying.

“It’s always fun to go back to communities and report results and see how people take those results and incorporate that knowledge and then ask new questions,” Malhi said. “I am now at this stage in my career where I have my students presenting at meetings. They spent years working really hard developing their research. When they put it all together and present it and the audience gets excited about it and the students are excited about it—that’s a really good feeling, too.”

Malhi also values being a part of the Summer Internship for Native Americans in Genomics (SING) workshop, which facilitate discussions about how genomic research is conducted and to create a support network for Native American students in the sciences.

Malhi earned a Master’s degree and a doctorate in anthropology at the University of California at Davis. He also took molecular biology, population genetics, and other biological courses to complement the anthropology curriculum. Today a student interested in this field can pursue graduate degrees in biological or molecular anthropology.

“I recall hearing about a genetic study where an Italian population did not get heart disease because they had a natural genetic variant, and I realized there’s lots of genetic variation out there that can be interesting and useful,” Malhi said. “Then I learned about connections with history and how you can infer human history from DNA variation, and I was hooked.”

The Institute for Genomic Biology (IGB) is dedicated to interdisciplinary genomic research related to health, energy, agriculture and the environment. The Institute’s cadre of world-class scientists, collaborative laboratories, and state-of-the-art equipment create an environment that inspires discovery and stimulates bioeconomic development at the University of Illinois. For more information about the SING workshop, visit http://conferences.igb.illinois.edu/sing/.