Considering Copernicus

Highly degraded DNA samples uncover the truth about the famed Polish astronomer

Sean Allocca

The astronomer that positioned the sun at the center of the universe—shattering the geocentric model of the heavens and thousands of years of accepted thought—has left modern-day researchers with one last scientific question to consider: are the remains excavated at the Frombork Cathedral in 2005 actually those of the famed Polish scientist Nicolaus Copernicus? A team of researchers from both Poland and Sweden set out to determine whether the information hiding in DNA sequences in the damaged bones would be enough to determine an identity back in 2009. The Swedish research group at Uppsala University was led professor Marie Allen. Now, Allen and her team want to figure out what other genetic information might be hiding in the almost 500-year-old bones.

By looking at single nucleotide polymorphism (SNP) markers, Allen hopes to find more information about externally visible characteristics, such as eye, hair and skin color as well as facial features to find out what Copernicus would have looked like in life. The team has already sequenced the entire mitochondrial DNA genome, and is now working with massive parallel sequencing including analysis of 900 DNA markers like autosomal short-tandem repeats (STRs), SNPs and insertion and deletions (InDels). "Of course, the sample is only yielding parts of this information as the DNA is degraded," Allen said. "But we are, however, hoping that we will get a bit more information about Copernicus and his life."

Some of the strongest evidence linking the remains to Copernicus are the bones themselves. They were found near an altar that Copernicus was responsible for during his time as a priest at the church. Copernicus eventually died when he was around 70 years old, and although some research has now refuted Copernicus' links to the ministry, it was common practice during many historical periods to bury priests near the altar they maintained in life.[1] "One of the 16 tombs was more interesting than the others because there was the skeleton of an old man," Allen said. "The skull also matched known features about Copernicus—a broken nose and damaged forehead."

These "morphological features" provide some of the strongest evidence that the remains are those of the famed Polish astronomer. Initial DNA testing came back with some positive results. The team's research found that three upper molars and both femurs had identical mitochondrial DNA profiles, suggesting that all of the bones came from a single individual.[2] The difficulty then became proving exactly who that person was.

By looking at SNP markers, Allen hopes to determine externally visible characteristics, such as eye, hair and skin color. (Courtesy: Marie Allen)

Copernicus's famous book

Another key in the investigation came when researchers decided to look for any reference DNA inside a book that belonged to Copernicus that is now on display at a museum in Sweden. Called the Calendarium Romanum Magnum, Allen and her team in Uppsala, Sweden had easy access to the book since it was plundered by the Swedes during a conquest in Poland in the mid-17th century.[2]

"Sometimes the Swedes can be not so friendly," Allen said about how the book ended up in Sweden.

Written by the German astronomer Johannes Stoeffler, the book contained charts and calendars used in astronomy and provided detailed information about the movements of celestial bodies. Inside the spine,

researchers found nine shed hairs. Out of the nine hairs that were within the pages of the book, four yielded genetic profiles useful for further analysis.[2] When the team compared the profiles, they found that two of the hairs were excluded as being from the same individual as the skeletal remains—and likely would have been from other people handling the book during Copernicus's time or in the centuries after his death. But, the other two hairs produced a mitochondrial DNA profile that exactly matched the DNA found in the skeletal remains from the Poland cathedral.[2]

Nuclear DNA vs. mtDNA

Although the researchers found mitochondrial DNA, the genetic information located in the nuclear DNA was much harder to retrieve in the highly degraded samples.

"We decided to search for hairs, and as we only found shed hairs we didn't find very much DNA in them" Allen said.

Out of the nine hairs that were found, four yielded genetic profiles for further comparison. (Courtesy: Marie Allen)

The lack of a nuclear DNA profile was likely not surprising to the scientist. When analyzing DNA samples taken from hair, the root of the hair contains almost all of the usable DNA. Shed hairs usually do not have the root attached meaning that scientists only have the hair shaft to analyze. Hair shafts, however, contain very few cells that can generally provide a high-quality nuclear DNA profile.

What Allen and her team did discover is that the hairs and the bones probably belonged to the same person, or close maternal relatives, but there was little way of knowing if that mitochondrial DNA profile definitely belonged to the famed Nicolas Copernicus.

"Alone in a court setting the mtDNA profile would not have been enough to support the hypothesis that the skeletal remains are those of Copernicus," Allen said. "But, taken together the historical files, the facial reconstruction, the archaeological data, and the morphological studies makes a strong case that those are his remains."

DNA Phenotyping

Once the remains were determined to possibly be those of Copernicus, Allen decided to further analyze the remains to see what other information might be gleaned from such degraded samples.

"In the first study, my Polish colleagues looked at a certain SNP for phenotyping analysis and discovered that Copernicus likely had blue or light eyes," Allen said. Finding out the externally visible characteristics of a decedent may provide further clues to determine the identity of found remains in for example missing person's cases. "We will try to analyze more SNPs to determine hair color, facial structure and try to provide even more information to the case," she said.

Because Copernicus died before he became famous, there are few known portraits that can be relied upon with certainty. Allen said that it is may be possible that artists would have colored charcoal depictions of the astronomer long after his death.

For now, Allen and her team will continue with their research to learn more about DNA phenotyping. She hopes to soon unlock more of the secrets of appearance hidden deep within a person's genome, and perhaps learn more from the bones discovered in a church in Poland and the famed astronomer Nicolas Copernicus.

"We're getting very interesting information, now that we are using new technology," Allen said.

References

1. Rosen E. (1971) Copernicus' alleged priesthood. Archiv Reformationgeschichte 62:90–98.
2. Bogdanowicz W., et al. (2009) Genetic identification of putative remains of the famous astronomer Nicolaus Copernicus. Proc Natl Acad Sci USA 106:12279–12282

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