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Ancient DNA Discovered from a 20,000-Year-Old Pendant

Historians know very little about the lives of Hominins (an overarching term for extinct *Homo* subspecies) during the Paleolithic Era, a prehistoric time period known as the Old Stone Age and characterized by the first stone tools ever created by Hominins ("Denisova Cave", n.d). This epoch in world history spans thousands of years; therefore, it is often unclear when Paleolithic artifacts were used, and they provide little information about Hominims during this time. Scientists have been able to extract DNA from prehistoric Hominin remains, such as teeth or bones, giving them a sense of the culture and environment in the Paleolithic era. However, it was only this year that scientists were able to recover DNA from artifacts (non-Hominin remains/body parts) without damaging them, and relate this DNA to exact, prehistoric individuals (Kuta, 2023).

Researchers at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, had a goal of being able to retrieve Hominin DNA from any Hominin artifact archaeologists had acquired, even if these artifacts contained skin cells or sweat from the archaeologists. Their second aim was to ensure the artifact would remain unharmed through their DNA extraction process. Leader Elena Essel and her group began to test the effects of numerous chemicals on prehistoric bones and teeth (Kuta, 2023). After much trial and error, Essel's team came upon a satisfying result: placing a porous artifact within a Sodium Phosphate solution while heating it to 90°C allowed them to retrieve DNA from the remaining liquid ("Scientists Recover", 2023). The bones were unharmed, which was of paramount importance to the scientists.

Essel and her team faced numerous roadblocks but eventually succeeded in their mission. Initially, when they tried to extract DNA from ancient French artifacts, they could only retrieve DNA from the animal the bone was from and the archaeologists' own DNA ("Scientists Recover", 2023). They also discovered that their technique only worked on artifacts covered in certain kinds of soil, but other soil types interfered with the DNA extraction from the artifact (Kuta, 2023). The team tried again using jewelry from Bulgarian caves where the first modern humans in Europe were believed to have lived ("Scientists Recover", 2023). In this trial, contamination was mitigated by using gloves and masks. Although there was no DNA extracted from the archaeologists this time, there was no DNA extracted from ancient Hominins either ("Scientists Recover", 2023).

In 2019, two archeologists uncovered an elk tooth in the Denisova Cave in Russia (Kuta, 2023). This cave, nestled in the Altai Mountains, has been an important site for archeologists previously, as it is where the first Hominin of mixed Denisova and Neanderthal descent was discovered ("Denisova Cave", n.d.). This elk tooth had a hole cut through it, suggesting it was used as a pendant for a piece of jewelry. This tooth, handled with utmost caution to prevent human contamination and loss of the surrounding soil, was then given to Essel. Her team performed their procedure using the Sodium Phosphate solution on the elk tooth. Not only could they identify DNA from the original elk, they finally were able to extract copious amounts of DNA from the prehistoric owner of this pendant (Kuta, 2023).

The DNA was extracted as follows: first, any sediment on the pendant was repeatedly rinsed with water, and a centrifuge was used to remove any remaining soil (Essel et al., 2023). The water and sediment were both used as sources of DNA. The pendant was then submerged in the Sodium Phosphate solution and incubated at increasingly higher temperatures before rinsed

and dried (Essel et al., 2023). All the liquids that the pendant had been submerged in were reduced in volume in order to provide a greater concentration of DNA (Essel et al., 2023). DNA was extracted from these liquids using a technique called DNA Separation by Silica Adsorption (Essel et al., 2023). Silica, or Silicon Dioxide, is a covalent compound, and DNA bonds to it when specific pH levels and salts are present, separating the DNA from the surrounding liquid ("DNA Separation", n.d). This DNA was then sequenced.

In their analysis, the researchers discovered that all of the ancient Hominin DNA probably came from a single person since the Mitochondrial DNA, the DNA portion that one inherits from their mother, stayed consistent ("Scientists Recover", 2023). Furthermore, because of the abundance of X Chromosomes, the researchers believe that the pendant's owner was a female ("Scientists Recover", 2023). Finally, through corroboration with ancient bone-DNA from surrounding areas, many connections were found between the DNA in the pendant and from these other individuals ("Scientists Recover", 2023). Overall, using DNA both from Hominin skeletal remains and from objects Hominins may have touched will lead historians and archaeologists to uncover many more facets of prehistoric life that would have otherwise been too distant to study. Moreover, it will help discern the evolutionary path of the Homo species and the interconnectedness of early humans.

While it may seem as though learning about extinct species from the Paleolithic Era does little to help us in the modern world, the major breakthrough from Essel's study was the ability to identify the age of the pendant without Carbon-14 (C14) Dating. The inference that the tooth was 19,000 to 25,000 years old came from the Hominin and deer Mitochondrial DNA, and the pendant remained intact after this process ("Scientists Recover", 2023). C14 dating has previously been the primary way to determine the age of ancient artifacts. However, it usually

destroys the artifacts in the process. This study's success has paved the way for new, non-destructive methods to determine the age of ancient artifacts.

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