

Analysis of the Evolution Evidence of Neandertals and Homo sapiens in Apidima Cave

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Abstract. Apidima Cave, which was first discovered by Theodore Pitsios and his team in the 1970s, is an archaeological site of great importance in the history of anthropology, and many fossils and artifacts were discovered. The most famous of these finds are the two skulls Apidima1 and Apidima2. These skulls have been identified as early members of the Homo sapiens family tree and are among the earliest known fossils of our species in Europe. All the caves were filled with geological sediments during the Middle and Late Pleistocene indicates that the area was a popular location for early humans to inhabit. The site's complex stratigraphic sequence, spanning the Middle and Upper Paleolithic periods, has allowed researchers to study the evolution of early humans over a long period of time. The cranial and occipital features of Apidima1 illustrate the evolution of the human brain in response to environmental adaptation. The large orbits and prognathic face of Apidima2 illustrate the natural selection of Neanderthals for adaptation to cold environments. The tools and artifacts found in archaeological sites can provide valuable insights into the social structure and daily lives of ancestors.

Keywords: Apidima Cave; Homo sapiens; Skull; Artefacts; Evolution.

1. Introduction

Apidima Cave is an archaeological site of great importance in the history of anthropology. It is located on the western coast of the Mani Peninsula in the southern Peloponnese Peninsula, Greece, and consists of five small cave groups. During the Ice Age, the cave did not stand on the sea cliff as it does now but could be directly accessed because the sea level dropped by more than 100 meters. Apidima Cave was first discovered by Theodore Pitsios and his team in the 1970s, and many fossils and artifacts were discovered. The stratigraphic sequence of the cave covers a period of more than 100,000 years from the Middle Pleistocene to the Holocene. The most famous of these finds belonged to the two skulls Apidima1 and Apidima2, both of which were found in the breccia of the sedimentary layer. Apidima1 is considered by researchers to be the earliest evidence of humans moving out of Africa. It contains many characteristics of modern humans but also presents some older and more primitive characteristics. Apidima2 is thought to be more representative of Neanderthals. The attribution of Apidima1 and Apidima2 has been continuously discussed in recent years, and the Homo sapiens hypothesis and the Homo erectus hypothesis provide different evidence. This term paper is to discuss the attribution of these two human skull fossils found in Apidima Cave, and to determine the different analysis methods and evidence for studying the skull.

2. Geographical Context

Apidima Cave is situated on the western coast of the Mani Peninsula near the village of Areopolis (Bräuer, 2019). The site consists of five caves on steep sea cliffs that are only accessible from the sea - this is due to rising sea levels about one hundred meters. In addition to the two skulls found at Apidima Cave, valuable fossils or human artifacts have also been found in four other caves. Cave Beta found Middle Paleolithic utensils and a human tooth. Cave Gamma yielded Upper Paleolithic assemblages and fauna, along with a buried skeleton of a young female. There are also other Neanderthal fossils unearthed at other sites similar to Apidima Cave in the Mani Peninsula. Lakions Cave is composed of a series of collapsed caves and normal caves, and the site preserves a rich, although highly fragmented, fauna, and very rich Middle Paleolithic lithium assemblages throughout

most of the stratigraphic sequence (Harvati, 2016). A human tooth found in the cave has provided important evidence of human evolution. All caves in Apidima Cave were filled with geological sediments during the Middle and Late Pleistocene. In the post-Pleistocene period, sea level rise led to severe seawater erosion, which is why Apidima1 and Apidima2 both had traces of seawater erosion when they were discovered. Judging from the rise in sea level, the environment when hominin fossils and artifacts were deposited was definitely colder than the current environment, which has implications for understanding the adaptation of early humans to changing environmental conditions.

The discovery of the two skulls at Apidima Cave in Greece in 1978 has provided valuable insights into the evolution of early humans. The skulls, named Apidima 1 and Apidima 2, are believed to be from two different hominin species, with Apidima 2 being the oldest, dating back around 210,000 years, and Apidima 1 being around 170,000 years old (Harvati et al., 2019). These skulls have been identified as early members of the *Homo sapiens* family tree and are among the earliest known fossils of our species in Europe. The presence of Middle and Upper Paleolithic utensils and assemblages in the other caves on the Mani Peninsula also provides valuable information about the lifestyles and cultures of early humans in the area. The fauna and lithic assemblages in Lakions Cave, in particular, suggest that early humans in the area were skilled hunters and toolmakers (Harvati, 2016). The fact that all the caves were filled with geological sediments during the Middle and Late Pleistocene indicates that the area was a popular location for early humans to inhabit.

3. Stratigraphy and Dating

The formation of Apidima Cave is difficult to describe, but researchers believe the remains were created by an erosion process. Over time, sea level rise and seawater erosion have further altered the cave. The stratigraphic sequence in Apidima Cave is complex and generally believed to be from the Middle Pleistocene 200,000 years ago to 30,000 to 40,000 years ago of the Upper Paleolithic. The dating methods used at this site are mainly U-series, U and Th concentrations were derived from repeated measurements of the NBS-610 standard, and U-isotope ratios from the dentine of a rhinoceros tooth from Hexian (Bartsiokas, 2017). The main reason for using U-series is that the site contains a large number of archaeological fossils and sediments, and Apidima Cave is surrounded by the ocean. Sites with a large amount of carbonate are most suitable for using the U-series dating method. The use of U-series identified Apidima1 at 210,000-200,000 years ago and Apidima2 at 170,000-160,000 years ago. This exact time frame continues to shrink as technology is updated. There have been some inconsistencies and debates regarding the stratigraphy and dating of Apidima Cave. For example, when Apidima1 and Apidima2 were first discovered, the two skulls were thought to be from the same period, but subsequent research determined that the two skulls differed by about 40,000 years. Determining the timeline and geological importance of the site ensures that hominid fossils can be accurately characterized when studying related hominid fossils, allowing researchers to draw accurate conclusions.

The use of dating techniques like U-series dating has been instrumental in determining the chronological age of Apidima Cave and the fossils found there. U-series dating relies on measuring the concentrations of uranium and thorium isotopes in a sample, and the technique is especially useful for dating sites that have a high concentration of carbonates, like the ones found in Apidima Cave. Despite the controversies, the dating and stratigraphic analysis of Apidima Cave have provided valuable insights into human evolution. The site's complex stratigraphic sequence, spanning the Middle and Upper Paleolithic periods, has allowed researchers to study the evolution of early humans over a long period of time. Moreover, the discovery of the Apidima1 and Apidima2 skulls, which are among the oldest known *Homo sapiens* fossils outside of Africa, has challenged existing theories about the origins and migration of early humans. Finally, the study of Apidima Cave and its fossils underscores the importance of preserving and studying archaeological sites to gain a better understanding of human evolution. By using a combination of dating techniques and stratigraphic analysis, researchers can continue to uncover new information about our evolutionary history and shed light on the mysteries of human origins.

4. Hominin Fossils

The two most famous human fossils found in Apidima Cave are Apidima1 and Apidima2. After U-series measurements, the time of Apidima1 was 210,000 years ago, and the time of Apidima2 was 170,000 years ago (Harvati, 2019). They are both in Middle Paleolithic and separated by a duration of about 40,000 years. Apidima1 appears to belong to males, while Apidima2 appears to belong to females. Both skulls belong to adults around the age of 30, but Apidima1 is a bit younger than Apidima2 (de Lumley, 2020). Compared with the Apidima2 skull, the Apidima1 skull is incomplete. There are four main bones: the incomplete left temporal, the left part of the occipital, and the two fragmentary left and right parietals (de Lumley, 2020). The anatomical features of Apidima1 are mainly manifested on the occiput. The occipital bones of African *Homo erectus* were lower and wider, while Neanderthals tended to be taller and narrower. Interestingly, Apidima1 falls in the positive range, approaching a more primitive structure (Rosas, 2020). The performance of Apidima1 in spatial morphology is closer to the characteristics of modern humans, which means that Apidima1 tends to be more inclined between *Homo erectus* and *Homo sapiens*. The anatomical features of the skull of Apidima2 mainly include post-orbital constriction, the supraorbital ridge and the orbital region. The post-orbital constriction of Apidima2 is less obvious. The supraorbital ridge of Apidima2 is more complete, characterized by the consistency of the size of the supraorbital ridge. It is capped by a clear supratrochlear fossa with fusion of the superciliary arch and orbital arch (de Lumley, 2020). Areas of the orbital region shows that the Apidima2 are more interbred with Neanderthals and other hominids. In terms of its morphology, supra-orbital torus, a wide interorbital breadth, large orbits and a prognathic face all show the Neanderthal or pre-Neanderthal affinities possessed by Apidima2. From the anatomical characteristics of the fossils, we can clearly understand the characteristics of human evolution. During this interval of 40,000 years, human species evolved in different directions. The cranial and occipital features of Apidima1 illustrate the evolution of the human brain in response to environmental adaptation. The large orbits and prognathic face of Apidima2 illustrate the natural selection of Neanderthals for adaptation to cold environments.

The cranial and occipital features of Apidima1 suggest adaptation to environmental factors, which could have played a role in the development of the human brain over time. Meanwhile, the large orbits and prognathic face of Apidima2 suggest adaptation to cold environments, which is consistent with what we know about the lifestyles and habitats of Neanderthals. It's important to note that the evolution of human species is a complex process that involves various factors such as genetics, behavior, and environment. Therefore, while anatomical characteristics of fossils can provide important clues, they only tell part of the story. To fully understand human evolution, it is necessary and meaningful to consider multiple lines of evidence and take a multidisciplinary approach that incorporates genetics, archaeology, and other fields of study.

5. Associated Artifacts

In addition to human skulls, several man-made artifacts were found at Apidima Cave. These artefacts include stone tools and flakes, as well as human-modified animal shells and animal remains. These artefacts all date to the Middle Paleolithic period, about 300,000 to 30,000 years ago. Meanwhile, an early Upper Paleolithic burial has also been found in Apidima Cave Γ (Pitsios 1985, 1995). However, no convincing chronological assessment exists for Cave Γ, and neither the skeleton nor the lithic and faunal material from this cave has been described in detail (Harvati, 2016). But many artifacts have been found in the Mani Peninsula where the Apidima caves are located. From a total of 1046 lithic artifacts, most of the stone tools are from 0.5 to 6 cm long (Vangelis, 2016). Their raw materials are mainly quartzite, andesite and quartz, and have obvious Middle Paleolithic technical characteristics. Most of them are side scrapers, end scrapers, piercers, denticulates and notches, which are distinct tool types crafted from flakes. They were likely used for a range of tasks such as hunting, processing food, and making other tools. The burial traces found in Apidima Cave are about the two skulls of Apidima. The two skulls were deposited side by side and 15 cm away from each other (de Lumley, 2020). No other human remains, or stone artifacts were associated with this burial ritual. Only three

pebbles that had gathered on the beach below were deposited nearby. Artifacts found in Apidima Cave and the surrounding area can tell us about the types of activities humans engaged in. Humans around Apidima Cave were mainly engaged in activities such as hunting, processing animal hides or cutting trees. At the same time, different types of tools also illustrate the different status and tasks of human beings in the group. For example, the length of some human artifacts can tell whether the user of the tool is male or female. In addition, these artifacts also illustrate the environmental problems of the area. As can be seen from the dating of the burial ritual found at Apidima Cave, it is a much colder period than now, marked by a major marine regression, and the coastline must have been at a much lower altitude than today (de Lumley, 2020).

The tools and artifacts found in archaeological sites can provide valuable insights into the social structure and daily lives of ancestors. In addition to gender differences in tool use, the distribution and types of tools can also reveal the division of labor, trade networks, and technological advancements of the time. Furthermore, the environmental context in which these artifacts were created and used is also important to consider. By analyzing the types of materials used and the techniques employed to create the tools, researchers can gain insight into the availability and quality of resources in the area. This, in turn, can shed light on how humans adapted to changes in their environment and how they developed innovative strategies to survive and thrive in challenging conditions.

6. Significance of the Site and Conclusion

Apidima Cave is one of the most important sites in human history. Greece represents a logical gateway through which early human populations might have repeatedly passed on the way to and from Europe (Harvati, 2017), and the evidence from the remains of this region is an essential part of human evolutionary history. Apidima Cave is generally considered from the Middle Pleistocene, 200,000 years ago, to the Late Paleolithic, 30,000-40,000 years ago. The discovery of Apidima1 and Apidima2 as important fossil skulls has significantly contributed to human evolution. Artifacts such as side scrapers, end scrapers, denticulates, and notches, also found in the Mani Peninsula, show human technology and hunting methods of the Middle Paleolithic. What makes Apidima Cave so important are two fossil skulls, Apidima1 and Apidima2. These two skulls are more diverse than the fossil record from most of Europe, reflecting the complexities of repeated dispersals, late survivals, and admixture of human groups (Harvati, 2019). The anatomical features of Apidima1 are more oriented towards *Homo erectus* and modern *Homo sapiens*, while the anatomical features of Apidima2 have characteristics of Heidelberg man and Neanderthal. The discussion and comparison of the two skulls is also what makes Apidima Cave so important. Discoveries in Apidima Cave provide an answer to the earliest out-of-Africa behavior in human evolutionary history. According to the U-series measurement, the age of the Apidima1 skull is 210,000 years old, which is the earliest evidence that humans have left Africa so far. Meanwhile, the evolution of the human skull over 40,000 years can be clearly seen from the anatomical features of Apidima1 and Apidima2. Apidima is a vital milestone for the understanding of the transition from evolved *Homo erectus* to Neanderthals in Mediterranean Europe (de Lumley, 2020). Apidima Cave also provided some intriguing interbreeding between *Homo sapiens* and Neanderthals. Although most of the skull features of Apidima1 belong to *Homo erectus* or *Homo sapiens*, there are still some parts that have not been identified. The same happens with Apidima2. These phenomena may provide new evidence for Neanderthal interbreeding.

Overall, the Apidima fossils provide intriguing evidence of interbreeding between *Homo sapiens* and Neanderthals. While the majority of the anatomical features of Apidima1 and Apidima2 are consistent with *Homo erectus* or *Homo sapiens*, some parts of the skulls remain unidentified, which could indicate Neanderthal interbreeding. This discovery suggests that interbreeding between different hominid groups was more common than previously thought and highlights the importance of studying fossils from different regions and time periods to understand human evolution.

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