INTEGRATION: Journal of Multidisciplinary Studies
ISSN 3123-6928 (online)
Vol. 1 Iss. 1 Pg. 51-64
https://ejournal.scmdigi.id/index.php/integration

Human evolution and early cultural development: a historical-paleoanthropological synthesis

Arditya Prayogi[1*], Riki Nasrullah[2], Novianto Ade Wahyudi[1], Muhammad Jembar Risky[1], Muhammad Akmal Pratama[1], M. Iftah Irzaqi[1], Muhammad Faisal Reza[1]
[1]Universitas Islam Negeri KH. Abdurrahman Wahid Pekalongan, Jawa Tengah, Indonesia
[2]Universitas Negeri Surabaya, Jawa Timur, Indonesia
*Correspondence author: arditya.prayogi@uingusdur.ac.id
DOI: https://doi.org/10.65881/integration.v1i1.11

ARTICLE INFO

History:
Submit: 12-07-2025
Revision: 12-15-2025
Accepted: 12-17-2025
Published: 12-19-2025

Keywords:
human evolution;
homo erectus;
early culture;
paleoanthropology;
cognitive development.

ABSTRACT

Purpose: to present a comprehensive and integrative analysis that explains how evolutionary changes shaped human cognition, behavior, and social complexity. This article examines the historical development of early human evolution as a multidisciplinary inquiry into biological transformation, technological progress, and cultural emergence from Homo erectus to Homo sapiens.
Method: A descriptive qualitative approach is used, supported by a systematic literature review, drawing on paleoanthropological findings, the archaeological record, and interdisciplinary theoretical frameworks.
Findings: human evolution was not linear but dynamic, influenced by environmental adaptation, migration patterns, controlled fire use, lithic technological innovation, and the development of symbolic thought and language. These findings highlight the gradual emergence of cultural intelligence as a defining feature of modern humans.
Implications: understanding human evolutionary pathways provides valuable insights into contemporary scientific discourse on identity, civilisation, and humanity's adaptive characteristics in facing future global challenges.
Originality: lies in its integrative synthesis, connecting biological evolution with cultural and cognitive dimensions to offer a holistic perspective rarely emphasised in conventional discussions of human origins.

Introduction

The study of early human evolution is an important topic in paleoanthropology and human history, as it provides a fundamental understanding of the long process that

shaped modern humans. Studies on human origins are not limited to biological aspects, but also include the development of social behavior, ecological adaptation, technological innovation, and the cultures that emerged along the evolutionary journey (Gowlett, 2016; Harari, 2017). In a global context, fossil findings such as homo erectus, homo heidelbergensis, neanderthals, and homo sapiens show that human evolution has followed a complex path influenced by interactions between genetic factors, the environment, and climate change (Tattersall, 2022). In Indonesia, the presence of paleoanthropological sites such as Sangiran further underscores the urgency of discussing this topic, as it contributes significantly to the international narrative of human evolution (Widianto, 2006).

Although the literature on human evolution is quite extensive, there remains a gap in the presentation of interdisciplinary studies that integrate biological, technological, and cultural aspects. Previous studies have tended to focus on species classification and fossil analysis. At the same time, other dimensions, such as migration patterns, language development, the formation of social institutions, and the emergence of symbolic behaviour, are often treated as supplementary rather than core to human development (Antón & Snodgrass, 2012; Boyd, 2018; Dahler, 2011). This indicates the need to rewrite the history of human evolution through a broader perspective and to consider the interactions between variables that influence the evolutionary journey.

In line with these needs, this article aims to present a comprehensive review of early human development using historical, theoretical, and descriptive-analytical approaches. This article provides a chronological explanation of the transformation of humans from homo erectus to homo sapiens, while also reviewing how cognitive changes and technological innovations such as fire control, the use of Acheulean stone tools, and cross-regional mobility became important indicators in the development of human intelligence and culture (Herrera & Bertrand, 2018). Thus, this article not only emphasises morphological changes but also highlights the capacity of humans, as a culture-bearing species, to continue adapting and innovating.

The novelty of this research lies in its interdisciplinary approach, which integrates human evolution through the interaction among biological, technological, cognitive, and cultural aspects. Unlike previous studies that tend to focus on species classification and fossil analysis, this article positions the development of cognition, technological innovation, and the formation of culture and social structures as core components in the process of human evolution from Homo erectus to homo sapiens. Furthermore, this research presents a chronological synthesis that links morphological changes with symbolic abilities, mobility, and cultural adaptation, thus offering a more holistic and relevant analytical framework for understanding the origins and identity of modern humans. The urgency of this study lies not only in its contribution to the development of scientific knowledge but also in its relevance to understanding modern human identity. Understanding the journey of human evolution provides historical context for the emergence of social structures, language, art, and belief systems that characterise human civilisation today. Thus, exploring early human evolution not only examines the past but also invites reflection on how humans evolved into rational, symbolic, and cultural beings (Newman & Newman, 2020).

This research aims to develop a comprehensive understanding of early human evolution by integrating biological, technological, cognitive, and cultural aspects within a coherent analytical framework. Specifically, this research aims to explain the process of human evolution from homo erectus to homo sapiens chronologically, identify the main factors, biological, environmental, and technological, that influenced these changes, and

analyze the role of early cognitive and cultural developments in the formation of modern human social structures and lifestyles. The expected contribution of this research is to provide a more holistic, interdisciplinary framework for the study of human evolution, complementing and enriching paleoanthropological studies that have tended to focus on morphological aspects. This research is expected to strengthen the understanding of humans as both biological and cultural beings, provide a conceptual basis for further interdisciplinary research, and serve as an academic reference in the development of anthropological studies, human history, and education. In addition, this research contributes to critical reflection on modern human identity by tracing the evolutionary roots of rationality, symbolism, and culture, which continue to shape human civilisation today.

Method

This article used a descriptive qualitative approach to examine the historical development of early humans, with a literature review as the primary data collection method. Data was collected from written sources, both printed and electronic, including academic journals, scientific articles, and relevant documentation on early human development. The data collection process was carried out systematically through the following stages: (1) identification of sources using academic databases such as Google Scholar and DOAJ; (2) selection of sources based on relevance to the theme; and (3) extraction of key information, namely identifying the main themes, by filtering the data based on criteria of suitability to the research objectives.

The data was analysed using data reduction techniques, namely narrowing the focus by eliminating irrelevant information, sharpening the findings, and grouping the data. This analysis aimed to produce a focused picture of the historical development of early humans. The data are presented in a descriptive narrative to provide a comprehensive understanding of the historical dynamics of early human development. Conclusions are drawn through triangulation of data from various sources to ensure the validity and consistency of the findings, and are supported by relevant literature. This relevant literature supports the conclusions, providing a coherent historical picture of early human development (Prayogi, 2025).

Results and discussion

The origin of homo erectus

The emergence of homo erectus marked an important step in human evolution, as the first species to walk upright like modern humans with a larger brain size than their predecessors. This species appeared in Africa around two million years ago, amid major climate changes that affected its habitat, including the spread of increasingly vast open grasslands (Stewart & Stringer, 2012). Homo erectus evolved from early species such as homo habilis, which had already begun to use simple tools, through an evolutionary process that involved the development of greater physical and cognitive abilities (Coqueugniot et al., 2004). These adaptations allowed them to survive in harsher conditions, with strong bodies that supported long journeys and exploration of new habitats. Additionally, Homo erectus is known as the first hominin to leave Africa (out of Africa), demonstrating remarkable adaptability in facing diverse environments (Dahler, 2011; Harari, 2017).

Based on the fossils and tools that have been found, homo erectus served as a link between the simple tool users of the past and the more intelligent modern humans of

today (Stout & Chaminade, 2012). Understanding their origins can help us see how physical adaptations and early technological innovations supported each other, forming the foundation for human spread and development. Homo erectus lived for a long period of time, from around 1.9 million to 110,000 years ago, making it one of the most successful hominins in evolutionary history (Reschke et al., 2024).

The first discovery of Homo erectus fossils occurred in the late 19th century, when Dutch scientist Eugene Dubois found remains in Indonesia known as "Java Man" in 1891 (Joordens et al., 2015). He named the species to emphasise its upright posture as a key feature. However, many scientists were initially sceptical because of features such as a low forehead and thick eyebrows that resembled those of primates. This discovery provided early evidence that human ancestors existed outside of Africa, challenging the long-held view that human origins were limited to Europe. Using modern dating methods, the age of this fossil is estimated to be between 100,000 and 1,000,000 years old (Herrera & Bertrand, 2018). This discovery inevitably sparked a major debate in the field of human evolution studies and became the basis for understanding homo erectus as a "world-traveling" species.

The physical adaptations of homo erectus made them resilient in various environments (Antón et al., 2016). They had an average height of around 1.6 to 1.8 meters, with body heat regulation capabilities suited to open areas. Long arms and legs and narrow hips allowed for efficient movement over long distances in response to past climate change. Their brains were larger, averaging around 1,000 cubic centimetres, indicating more complex thinking abilities, such as problem-solving or social interaction. Smaller teeth with thick enamel indicate a diet that included hard foods, such as cooked meat. All of these characteristics gave them a competitive advantage and formed the basis of the human body shape we see today. Additionally, homo erectus had a low, receding forehead and a broad nose, which supported their active lifestyle (Widianto & Noerwidi, 2020).

One of the most notable aspects of homo erectus is its journey out of Africa (out of Africa) around 1.8 million years ago, which was the first expansion into Asia and Europe (Potts & Teague, 2010). Fossils show individuals with varying brain sizes crossing various terrains, aided by climate changes such as sea level decline. Findings such as "Peking Man" illustrate how they adapted to new environments. Such conditions created opportunities for future cultural variation. This migration also made homo erectus the first species to inhabit a large area outside its native continent, demonstrating remarkable colonisation abilities (Árnason & Hallström, 2020).

The core of homo erectus culture lies in the manufacture of more advanced stone tools, which began around 1.7 million years ago (Corvinus, 2004). Tools such as symmetrically carved hand axes demonstrate planning and skill, often used to process food or other materials. Similar tool shapes in different places indicate that they learned from or imitated each other, as the beginning of better social interaction. This innovation reflects increased intelligence, as homo erectus began to develop technologies that supported their survival in a changing environment (Widianto, 2006).

There is evidence that homo erectus began to exhibit basic social behavior, such as hunting together or sharing food, which became the foundation for more structured groups (Layton et al., 2012). The use of fire, one of their early achievements, helped them cook, warm themselves, and gather together, thereby strengthening relationships among members. Although evidence of language is still limited, their brain structure suggests a simple ability to communicate through gestures or sounds. This social

approach helped them overcome natural challenges and pass on knowledge to the next generation, preserving their culture (Boyd, 2018).

The story of the origins and early culture of homo erectus is thus an important foundation in early human history, especially with its influence still felt in subsequent evolution. The combination of physical strength, improved tools, and social bonds allowed them to survive for nearly two million years, longer than many other species. Their legacy is evident in modern human genes and in the evolution of basic technologies, reminding us of the interconnection between biology and culture in shaping the human journey.

Dynamics of homo erectus life

The dynamics of homo erectus' life can be clearly seen through their technological developments and environmental adaptations. This species made significant progress in human evolution, successfully overcoming various natural challenges while developing better tools. This period lasted from the early to mid-ice age, marked by a transition from simple tools to innovations that supported survival in diverse habitats (Antón, 2003).

Homo erectus did not rely solely on physical strength; they also used their intelligence to develop technological solutions that enabled them to spread to new areas, such as from Africa to other continents (Clark, 1992). This ability became the basis for coping with global climate change, which in turn encouraged the development of a more flexible culture. Furthermore, this adaptation was supported by archaeological evidence showing an increase in their brain size, which reached an average of 900-1,100 cubic centimetres, enabling more complex thinking than their predecessors, such as homo habilis (Rightmire, 2013).

The development of stone tools was one of the major achievements of homo erectus (Corvinus, 2004). This process began with simple tools, such as sharp stone blades for cutting, and evolved into more advanced tools around 1.7 million years ago. These advanced tools involved carving stone on both sides to produce balanced, useful shapes, as seen in the Acheulean tradition. This innovation enhanced planning abilities and fine motor skills, enabling the tools to be used for various tasks, such as food processing and hunting (Widianto, 2006). This change was not merely a technical matter but also a response to increasingly complex environmental needs, in which these tools aided the more efficient exploitation of natural resources. Additional information indicates that this technology spread widely, reflecting homo erectus' ability to transmit knowledge between generations through social learning (Boyd, 2018).

Advanced stone tools, such as symmetrical hand axes, represent a "great leap" in ancient technology, with evidence of their spread from Africa to Asia and Europe (Wynn, 2002). These tools are often found at excavation sites, where their versatility is evident, from cleaning animals to cutting natural materials such as wood or leather. In Asia, for example, simple stone tools such as choppers remained common until a million years ago, before gradually becoming smaller and more varied. However, in some areas, more complex tools appeared, possibly due to encounters with other groups, although evidence of such interactions is scarce. This development not only improved hunting and foraging efficiency but also supported adaptation to seasonal changes and resource availability, thereby strengthening the survival of this species across various ecosystems (Fauzi et al., 2015; Prayogi, 2021).

In addition to the use of stone tools, the mastery of fire was an important technological innovation for homo erectus, with early evidence dating back to around

790,000 to 500,000 years ago at various sites (Ayres, 2021). Fire was used not only for cooking food, which improved nutrition and reduced the risk of disease from raw food, but also for warming the body in cold weather and for protection against predators. Findings such as burnt stones, charcoal, and ash confirm that fire control had become an integral part of environmental adaptation (Glikson, 2013). However, the scientific evidence for how it was controlled remains a matter of debate. This innovation contributed to the development of larger brains, as cooked food enabled more efficient energy absorption, ultimately supporting higher cognitive abilities. Additional evidence from research shows that the use of fire also facilitated social activities, such as gathering around campfires to share stories or knowledge (Gowlett, 2016).

The environmental adaptation of homo erectus became increasingly apparent in its ability to cope with extreme weather during the glacial period, including dry periods that caused drastic environmental changes (Potts, 2012). This species survived by occupying areas near water sources, which served as ecological centres to mitigate the effects of drought. Several studies indicate that homo erectus was able to adapt to environments such as arid conditions at least 1.2 million years ago, with evidence of their repeated presence in these difficult areas. This flexibility was supported by technology that enabled the exploitation of limited resources, such as digging tools for roots or hunting small animals. Related information also indicates that this adaptation involved changes in diet, with increased consumption of meat and cooked foods, contributing to increases in body and brain size (Twomey, 2013).

The "out of Africa" theory is the main foundation that states that the spread of homo erectus outside Africa is a clear example of environmental adaptation aided by technology (Heine, 2024). In Asia, they adapted to warm and moderate climates, while in Europe, they faced colder conditions with more effective tools. This spread shows that environmental changes, such as sea-level decline during the ice age, opened new paths and that technology was a major contributor to this process. In some parts of Asia, the use of materials other than stone, such as wood or bamboo, has been recorded, which explains the scarcity of stone tools found in these areas. This technological development reflects the increased thinking abilities of homo erectus, whose larger brains (averaging 1,000 cubic centimetres) enabled future planning and learning from peers, thereby strengthening group bonds and cultural transmission (Dunsworth, 2010). Such dynamics laid the foundation for subsequent human evolution, demonstrating how cultural innovation can overcome physical limitations and even trigger biological adaptation. This ability not only ensured that Homo erectus survived for nearly 1.5 million years, but also served as a bridge to the more complex behavior of the next species, modern humans (homo sapiens). Furthermore, the legacy of homo erectus is evident in the human genome today, where a small portion of their DNA still exists in non-African populations, providing evidence of ongoing evolutionary interaction and adaptation (Maslin et al., 2015).

Evolutionary transition: the emergence of homo heidelbergensis and Neanderthals

The evolutionary transition from homo erectus to homo heidelbergensis and neanderthal marks an important phase in the human lineage, in which intermediate species appeared to connect early primitive forms with more advanced ones (Tattersall & Schwartz, 2009). This period, which lasted from approximately 700,000 to 200,000 years ago, reflects gradual adaptations to environmental and social changes, which ultimately shaped the diversity of early humans. Homo heidelbergensis is often seen as a key link, evolving from Homo erectus and becoming the ancestor of Neanderthals and

other species, including modern humans. This process shows that evolution did not proceed linearly, but rather involved branches influenced by factors such as migration, geographic isolation, and environmental pressures. In addition, fossil evidence shows that this transition occurred in various regions, including Africa and Eurasia, enriching our understanding of the dynamics of human evolution (Antón & Snodgrass, 2012).

Homo heidelbergensis emerged as a transitional species that combined the characteristics of homo erectus with innovations, such as a larger brain and stronger bone structure (Manzi, 2011). This species is believed to have evolved from a widespread population of homo erectus, with an average brain size of around 1,200 cubic centimetres, indicating an increase in cognitive abilities (Tattersall & Schwartz, 2009). This supported more complex behaviors, such as long-term planning and improved social interactions (Newman & Newman, 2020). These adaptations allowed them to survive in changing climates, including increasingly intense cold periods, and laid the foundation for further evolutionary divergence. Related information indicates that Homo heidelbergensis lived approximately 600,000 to 200,000 years ago, with fossils showing a gradual anatomical transition toward modern human form.

The origins of homo heidelbergensis are closely linked to homo erectus, with fossil evidence showing gradual changes in skulls and tools used (Manzi, 2011). This transition occurred around 800,000 years ago, with features such as a higher forehead and smaller jaws beginning to appear, indicating an evolution towards a face more similar to modern humans. This evolution was likely driven by environmental pressures, such as climate change affecting food availability and habitat. As a result, homo heidelbergensis became a more flexible species, capable of exploring new territories. Additional information from paleoanthropological research suggests that this species may be the common ancestor of neanderthals in Europe and homo sapiens in Africa (May, 2022). This is an important point regarding its role in the multiregional evolution model.

The dynamics of homo heidelbergensis life show a more organised lifestyle than homo erectus (Antón et al., 2014). They lived in small groups, working together to hunt large animals such as deer and buffalo, which required strategy and teamwork. Paleontological evidence shows that they began using temporary shelters, such as caves, to protect themselves from bad weather. They also showed signs of caring for one another, such as tending to injured group members, indicating closer social bonds. In addition, this dynamic also included the routine use of fire for cooking and warming the body, which not only increased nutritional efficiency but also strengthened communal relationships within the group (Tattersall, 2022).

Technology during the homo heidelbergensis period included more refined stone tools, which later became characteristic of Neanderthals (Hoffecker, 2018). These tools were made using more sophisticated techniques and were used for hunting and processing materials such as wood or animal skins. These technological innovations reflected advances in planning and group cooperation, which became the foundation for more advanced cultures. Compared to the tools of homo erectus, these tools were more efficient in dealing with diverse environments, from wilderness to open fields. They also developed spears with stone heads, indicating an increase in practical intelligence that improved long-distance hunting (Tattersall, 2022).

Homo neanderthalensius then emerged as descendants of homo heidelbergensis, primarily in glacial regions, around 400,000 years ago, as a response to extremely cold climates. They had short, stocky bodies and brains the size of modern humans (averaging 1,450 cubic centimetres), which allowed adaptations such as making clothing

from animal skins and living in caves to survive (Newman & Newman, 2020; Tattersall, 2022). This evolution shows regional specialisation, where geographic isolation separated them from the African populations that led to modern humans. Homo Neanderthal serves as an example of how evolutionary transitions produce unique variations, with physical adaptations tailored to the harsh Pleistocene environment.

The life of homo neanderthal shows a rich social dynamic, as evidenced by the practice of deliberately burying members of the group, which indicates a certain respect or belief regarding death (Nielsen et al., 2020). They also made simple markings on stones, which may have been an early form of art, and were skilled at hunting large animals with tools adapted to the cold environment. These changes highlight that evolution is not only about physical abilities but also involves deeper cultural and cognitive developments. The interaction of homo neanderthalus with other groups, including early modern humans, is evident from genetic evidence showing gene mixing. Some homo neanderthalus genes still exist in modern humans. This provides adaptive advantages such as resistance to disease or cold weather. DNA analysis shows that this mixing occurred around 40,000-50,000 years ago, when Homo sapiens arrived in Europe (Pettitt, 2010).

The debate about human origins, such as the "out of Africa" theory versus the multiregional model, explains how this transition involved migration and interbreeding, not just the replacement of one species by another. This enriches our understanding of human evolutionary continuity, in which homo neanderthalus did not become completely extinct but contributed to the genome of contemporary humans. In addition, archaeological evidence such as cave paintings and simple jewellery shows that homo neanderthal had symbolic abilities, which were previously thought to be exclusive to homo sapiens (Christian, 2015).

The dynamics of Neanderthal life also included their ability to survive in harsh environments, with hunting large animals being an important part of their routine (Stewart et al., 2019). They developed advanced hunting techniques, such as using sharp wooden spears to attack at close range, and regularly used fire for cooking and warming themselves. This strengthened group bonds when gathering, reflecting the high intelligence and cooperation inherited from homo heidelbergensis. Paleontological evidence also shows that they consumed a varied diet, including plants and fish, indicating flexible dietary adaptation (Christian, 2015).

The transitional stages from homo erectus to homo heidelbergensis and neanderthal show diversity in early human history. This process not only shaped physical and cultural aspects but also paved the way for the emergence of Homo sapiens. The implication is that evolution is a dynamic process in which adaptation, interaction, and innovation are key to human survival and development.

The emergence of homo sapiens and early modern culture

The emergence of homo sapiens marked the peak of prehistoric evolution, with this species appearing as a modern human form with superior cognitive abilities, distinguishing it from its predecessors, such as Homo erectus and Neanderthals (Ramesh, 2025). The origins of Homo sapiens are believed to have begun in Africa around 300,000 years ago, based on the oldest fossil evidence from the Jebel Irhoud site in Morocco, which shows characteristics such as a flat face and small teeth similar to those of humans today. This species evolved from early hominin populations through adaptation driven by climate and environmental change, resulting in a larger brain with an average volume of 1,350 cubic centimetres. This ability laid the foundation for an

innovative cultural explosion, making homo sapiens the dominant species capable of developing symbolic behavior and advanced technology. In addition, modern genetic evidence shows that homo sapiens had high genetic diversity in Africa, supporting the theory of a single origin from that continent (Hublin et al., 2017).

The fossils from Jebel Irhoud not only confirm the early age of homo sapiens, but also show a mixture of primitive and modern features, such as a slightly receding forehead but with a brain capacity close to that of contemporary humans (Hublin et al., 2017). This site, discovered in the 1960s, provides evidence of their early lifestyle, including the use of fire and simple stone tools. This development occurred during the late Pleistocene, when climatic changes, including drought, forced adaptations in the search for food and water (Hublin et al., 2017). Then, about 200,000 years ago, homo sapiens populations began to show signs of a more advanced culture, which became the foundation for subsequent migration. Related information from ancient DNA research reveals that this species interacted with other groups, such as Neanderthals, who left a genetic trace of up to 2-4 percent in non-African humans today (Christian, 2015; Sahle & Wilkins, 2024).

The global migration of homo sapiens, often referred to as "out of Africa II," began around 70,000 to 50,000 years ago, during which they spread from Africa to Eurasia, Australia, and eventually the Americas (Willoughby, 2009). This migration was facilitated by a drop in sea levels during the last ice age, opening up land corridors such as through the Middle East. Fossil evidence shows the early presence of Homo sapiens outside Africa, with fossils dating back around 100,000 years indicating interaction with local Neanderthals. This process involved not only physical dispersal, but also cultural exchange, with Homo sapiens bringing superior technological innovations. Additionally, modern population-genetic models estimate that these migration waves involved small groups that later developed into large populations across various continents. This genetic development also explains the current diversity of languages and cultures (Dunsworth, 2010; Herrera & Bertrand, 2018).

The cognitive revolution, which occurred around 70,000 years ago, was a turning point at which Homo sapiens developed the abstract and symbolic thinking abilities that distinguished them from other species (Tattersall, 2010). Technological innovations, such as precise stone carving techniques to produce sharp blades, reflect long-term planning and advanced technical skills. Cave art, such as that found at prehistoric archaeological sites, shows early artistic expression with images of animals and abstract patterns that may be related to rituals or stories. This revolution is thought to have been triggered by genetic mutations that enhanced language and imagination. Related neuroanthropological studies show that the Homo sapiens brain has a more developed prefrontal cortex, which supports creativity and complex problem-solving (Tylén et al., 2020).

Elements of homo sapiens culture include language, art, and increasingly complex burial rituals, as seen in the form of carvings on stones and beads (Solomon, 2019). Burial rituals, for example, show burials with personal items, indicating a belief in life after death or social status. Language, although it leaves no direct fossil evidence, is believed to have emerged as a symbolic communication tool that enabled the spread of knowledge and myths. Art, such as cave paintings, reflects rich emotional and cultural expression.

Early technologies developed by homo sapiens included composite tools, such as spears with stone heads attached using natural resin, which improved hunting and defence effectiveness (Kumar & Dixit, 2019). This innovation, which emerged around

60,000 years ago, demonstrates an understanding of natural materials and bonding techniques, enabling the creation of lighter and sharper tools. Additionally, the use of bone needles to sew clothing from animal skins is evidence of adaptation to cold climates during the ice age, which supported migration to northern regions. This technology was not only practical but also reflected cognitive advancement, as homo sapiens began combining different materials to create innovative solutions (Prayogi, 2016). These various developments contributed to the increase in population and global spread of homo sapiens.

Early homo sapiens culture was also notable for its musical and jewellery practices, such as the bone flutes found in European caves, which indicate the use of sound for rituals or social entertainment. Jewellery made from animal shells or teeth, often found at African settlement sites, also reflects expressions of personal identity or status within the group. These cultural elements strengthened social bonds, enabling the formation of larger, more organised societies. In addition, evidence of trade in rare materials between groups indicates the existence of early social networks, which laid the foundation for future complex societies. Related information from ethnoarchaeological studies links these practices to unique symbolic abilities that distinguished homo sapiens from other hominin species (Prasetyo, 2014; Prayogi & Anggraeni, 2022).

Homo sapiens culture thus laid the foundation for modern civilisation. However, interpreting archaeological data poses challenges, such as incomplete fossils or biases in excavated sites, which require multidisciplinary approaches, including genetics and computer simulation. This reflection reminds us that prehistoric culture is not only a biological inheritance (Prayogi, 2023), but also a culture that continues to shape human identity today.

The results of this study indicate that human evolution cannot be understood solely through biological or morphological changes, but must be seen as a multidimensional process involving interactions among biological, technological, environmental, cognitive, and cultural factors. These findings reinforce the importance of an interdisciplinary approach to the study of human evolution, as data from paleoanthropology, archaeology, genetics, and cultural studies complement one another in reconstructing human history more accurately. Furthermore, this study has implications for understanding modern human identity by demonstrating that the ability for symbolic thought, language, social cooperation, and technological innovation is the result of a long, adaptive, and collective evolutionary process. More broadly, the results of this study can serve as a conceptual foundation for studies in anthropology, history, and education and encourage critical reflection on how evolutionary legacies shape human behavior, culture, and civilisation to this day.

Conclusions

Studies of early human evolution show that the long journey from homo erectus to homo sapiens was not simply a linear biological process, but rather a complex transformation influenced by dynamic interactions between the environment, behavioral adaptation, technological innovation, and cognitive development. Diverse paleoanthropological and archaeological findings show that the emergence of modern humans was not the result of spontaneous change. However, rather a gradual accumulation of symbolic abilities, adaptive intelligence, and cultural ideas passed down from generation to generation. Thus, human evolution must be understood as a multidimensional phenomenon: integrating physical, social, ecological, and intellectual

aspects into a single framework of interrelated historical development. This knowledge not only clarifies the origins of modern humans but also shows that the capacities for critical thinking, creativity, and communication are fundamental traits that have evolved over a very long period.

In addition, reflection on human evolution has important implications for understanding humans' position in contemporary civilisation. The awareness that modern humans are the result of a long process of adaptation teaches us that innovation, social cooperation, and the ability to learn are the foundations of human sustainability. This understanding opens new perspectives in education, interdisciplinary research, and the preservation of archaeological heritage as part of humankind's scientific and cultural identity. Therefore, further research through an integrative approach is needed to expand and deepen knowledge about the evolution of homo sapiens and its implications for the future of humans as a species. Thus, this conclusion not only closes the discussion but also opens new directions for further scientific exploration of the long and adaptive history of humans as cultural beings.

References

Antón, S. C. (2003). Natural history ofHomo erectus. *American Journal of Physical Anthropology*, *122*(S37), 126–170. https://doi.org/10.1002/ajpa.10399

Antón, S. C., Potts, R., & Aiello, L. C. (2014). Evolution of early Homo : An integrated biological perspective. *Science*, *345*(6192). https://doi.org/10.1126/science.1236828

Antón, S. C., & Snodgrass, J. J. (2012). Origins and Evolution of Genus Homo. *Current Anthropology*, *53*(S6), S479–S496. https://doi.org/10.1086/667692

Antón, S. C., Taboada, H. G., Middleton, E. R., Rainwater, C. W., Taylor, A. B., Turner, T. R., Turnquist, J. E., Weinstein, K. J., & Williams, S. A. (2016). Morphological variation in Homo erectus and the origins of developmental plasticity. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1698), 20150236. https://doi.org/10.1098/rstb.2015.0236

Árnason, Ú., & Hallström, B. (2020). The reversal of human phylogeny: Homo left Africa as erectus, came back as sapiens sapiens. *Hereditas*, *157*(1), 51. https://doi.org/10.1186/s41065-020-00163-9

Ayres, R. U. (2021). Fire and Water: Technologies Extending Nature. In *The History and Future of Technology* (pp. 7–31). Springer International Publishing. https://doi.org/10.1007/978-3-030-71393-5_2

Boyd, B. (2018). The evolution of stories: from mimesis to language, from fact to fiction. *WIREs Cognitive Science*, *9*(1). https://doi.org/10.1002/wcs.1444

Christian, D. (2015). *The Cambridge World History: Volume I: Introducing World History, to 10,000 BCE*. Cambridge University Press.

Clark, J. D. (1992). African and Asian perspectives on the origins of modern humans. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *337*(1280), 201–215. https://doi.org/10.1098/rstb.1992.0098

Coqueugniot, H., Hublin, J.-J., Veillon, F., Houët, F., & Jacob, T. (2004). Early brain growth in Homo erectus and implications for cognitive ability. *Nature*, *431*(7006), 299–302. https://doi.org/10.1038/nature02852

Corvinus, G. (2004). Homo erectus in East and Southeast Asia, and the questions of the age of the species and its association with stone artifacts, with special attention to handaxe-like tools. *Quaternary International*, *117*(1), 141–151. https://doi.org/10.1016/S1040-6182(03)00124-1

Dahler, F. (2011). *Teori Evolusi: Asal dan Tujuan Manusia*. PT Kanisius.

Dunsworth, H. M. (2010). Origin of the Genus Homo. *Evolution: Education and Outreach*, *3*(3), 353–366. https://doi.org/10.1007/s12052-010-0247-8

Fauzi, M. R., Intan, M. F. S., & Simanjuntak, T. (2015). Karakter Teknologi Litik Homo Erectus Progresif Berdasarkan Himpunan Artefak Dari Situs Matar, Bojonegoro. *KALPATARU*, *24*(1), 1–11. https://ejournal.brin.go.id/kalpataru/article/view/2624

Glikson, A. (2013). Fire and human evolution: The deep-time blueprints of the Anthropocene. *Anthropocene*, *3*, 89–92. https://doi.org/10.1016/j.ancene.2014.02.002

Gowlett, J. A. J. (2016). The discovery of fire by humans: a long and convoluted process. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1696), 20150164. https://doi.org/10.1098/rstb.2015.0164

Harari, Y. N. (2017). *Sapiens: Riwayat Singkat Umat Manusia*. Kepustakaan Populer Gramedia.

Heine, K. (2024). Human Development and Climate (Excursus). In *The Quaternary in the Tropics* (pp. 587–604). https://doi.org/10.1007/978-3-031-31921-1_9

Herrera, R. J., & Bertrand, R. G. (2018). *Ancestral DNA, Human Origins, and Migrations*. Academic Press.

Hoffecker, J. F. (2018). The complexity of Neanderthal technology. *Proceedings of the National Academy of Sciences*, *115*(9), 1959–1961. https://doi.org/10.1073/pnas.1800461115

Hublin, J.-J., Ben-Ncer, A., Bailey, S. E., Freidline, S. E., Neubauer, S., Skinner, M. M., Bergmann, I., Le Cabec, A., Benazzi, S., Harvati, K., & Gunz, P. (2017). New fossils from Jebel Irhoud, Morocco and the pan-African origin of Homo sapiens. *Nature*, *546*(7657), 289–292. https://doi.org/10.1038/nature22336

Joordens, J. C. A., D'Errico, F., Wesselingh, F. P., Munro, S., de Vos, J., Wallinga, J., Ankjærgaard, C., Reimann, T., Wijbrans, J. R., Kuiper, K. F., Mücher, H. J., Coqueugniot, H., Prié, V., Joosten, I., van Os, B., Schulp, A. S., Panuel, M., van der Haas, V., Lustenhouwer, W., … Roebroeks, W. (2015). Homo erectus at Trinil on Java used shells for tool production and engraving. *Nature*, *518*(7538), 228–231. https://doi.org/10.1038/nature13962

Kumar, N., & Dixit, A. (2019). Historical Perspective of Materials and Contemporary Warfare Technologies. In *Nanotechnology for Defence Applications* (pp. 1–33). Springer International Publishing. https://doi.org/10.1007/978-3-030-29880-7_1

Layton, R., O'Hara, S., & Bilsborough, A. (2012). Antiquity and Social Functions of Multilevel Social Organization Among Human Hunter-Gatherers. *International Journal of Primatology*, *33*(5), 1215–1245. https://doi.org/10.1007/s10764-012-9634-z

Manzi, G. (2011). Before the Emergence of Homo sapiens : Overview on the Early-to-Middle Pleistocene Fossil Record (with a Proposal about Homo heidelbergensis at the subspecific level). *International Journal of Evolutionary Biology*, *2011*, 1–11. https://doi.org/10.4061/2011/582678

Maslin, M. A., Shultz, S., & Trauth, M. H. (2015). A synthesis of the theories and concepts of early human evolution. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *370*(1663), 20140064. https://doi.org/10.1098/rstb.2014.0064

May, A. (2022). Since when have humans had a soul? *HTS Teologiese Studies /*

Theological Studies, *78*(2). https://doi.org/10.4102/hts.v78i2.7311

Newman, B. M., & Newman, P. R. (2020). Evolutionary theory. In *Theories of Adolescent Development* (pp. 15–40). Elsevier. https://doi.org/10.1016/B978-0-12-815450-2.00002-4

Nielsen, M., Langley, M. C., Shipton, C., & Kapitány, R. (2020). Homo neanderthalensi s and the evolutionary origins of ritual in Homo sapiens. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1805), 20190424. https://doi.org/10.1098/rstb.2019.0424

Pettitt, P. (2010). *The Palaeolithic Origins of Human Burial*. Routledge. https://doi.org/10.4324/9780203813300

Potts, R. (2012). Evolution and Environmental Change in Early Human Prehistory. *Annual Review of Anthropology*, *41*(1), 151–167. https://doi.org/10.1146/annurev-anthro-092611-145754

Potts, R., & Teague, R. (2010). Behavioral and Environmental Background to 'Out-of-Africa I' and the Arrival of Homo erectus in East Asia. In *Out of Africa I* (pp. 67–85). https://doi.org/10.1007/978-90-481-9036-2_5

Prasetyo, B. (2014). Perkembangan Budaya Akhir Pleistosen-Awal Holosen Di Nusantara. *KALPATARU*, *23*(1), 1–16. https://ejournal.brin.go.id/kalpataru/article/view/2613

Prayogi, A. (2016). Dinamika Identitas Budaya Melayu Dalam Tinjauan Arkeo-Antropologis. *Tamaddun: Jurnal Kebudayaan Dan Sastra Islam*, *16*(1), 1–20. https://jurnal.radenfatah.ac.id/index.php/tamaddun/article/view/829

Prayogi, A. (2021). Paradigma Positivisme dan Idealisme dalam Ilmu Sejarah: Tinjauan Reflektif Terhadap Posisi Sejarah Sebagai Ilmu. *Tamaddun: Jurnal Kebudayaan Dan Sastra Islam*, *21*(1), 75–90. https://jurnal.radenfatah.ac.id/index.php/tamaddun/article/view/8732

Prayogi, A. (2023). The Role of History as a Science in Sustainable Development. *West Science Interdisciplinary Studies*, *1*(1), 16–23. https://wsj.westsciences.com/index.php/wsis/article/view/5

Prayogi, A. (2025). *Persepsi Dan Minat Siswa Disabilitas-Sekolah Luar Biasa Negeri Wiradesa Pekalongan Melanjutkan Pendidikan Di Perguruan Tinggi Agama Islam Negeri* [Universitas Muhammadiyah Ponorogo]. https://eprints.umpo.ac.id/17554/

Prayogi, A., & Anggraeni, D. (2022). Perkembangan Tema Dalam Historiografi Islam: Suatu Telaah. *Studi Multidisipliner: Jurnal Kajian Keislaman*, *9*(1), 33–56. https://doi.org/10.24952/multidisipliner.v9i1.5121

Ramesh, S. (2025). The Rise of Homo sapiens. In *The Political Economy of Contemporary Human Civilisation, Volume I* (pp. 29–69). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-84181-1_2

Reschke, J.-O., Krüger, S., & Hertler, C. (2024). Early hominins: Successful hunters, catchers, or scavengers? An agent-based model about hunting strategies in tropical grasslands. *Quaternary Environments and Humans*, *2*(5), 100019. https://doi.org/10.1016/j.qeh.2024.100019

Rightmire, G. P. (2013). Homo erectus and Middle Pleistocene hominins: Brain size, skull form, and species recognition. *Journal of Human Evolution*, *65*(3), 223–252. https://doi.org/10.1016/j.jhevol.2013.04.008

Sahle, Y., & Wilkins, J. (2024). Africa, South: Middle Stone Age. In *Encyclopedia of Archaeology (Second Edition)* (pp. 21–28). Elsevier. https://doi.org/10.1016/B978-0-323-90799-6.00022-7

Solomon, A. (2019). Bones, Pigments, Art and Symbols. In *The Evolution of Religion, Religiosity and Theology* (pp. 256–270). Routledge. https://doi.org/10.4324/9780429285608-16

Stewart, J. R., García-Rodríguez, O., Knul, M. V., Sewell, L., Montgomery, H., Thomas, M. G., & Diekmann, Y. (2019). Palaeoecological and genetic evidence for Neanderthal power locomotion as an adaptation to a woodland environment. *Quaternary Science Reviews*, *217*, 310–315. https://doi.org/10.1016/j.quascirev.2018.12.023

Stewart, J. R., & Stringer, C. B. (2012). Human Evolution Out of Africa: The Role of Refugia and Climate Change. *Science*, *335*(6074), 1317–1321. https://doi.org/10.1126/science.1215627

Stout, D., & Chaminade, T. (2012). Stone tools, language and the brain in human evolution. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1585), 75–87. https://doi.org/10.1098/rstb.2011.0099

Tattersall, I. (2010). Human evolution and cognition. *Theory in Biosciences*, *129*(2–3), 193–201. https://doi.org/10.1007/s12064-010-0093-9

Tattersall, I. (2022). *Understanding Human Evolution*. Cambridge University Press.

Tattersall, I., & Schwartz, J. H. (2009). Evolution of the Genus Homo. *Annual Review of Earth and Planetary Sciences*, *37*(1), 67–92. https://doi.org/10.1146/annurev.earth.031208.100202

Twomey, T. (2013). The Cognitive Implications of Controlled Fire Use by Early Humans. *Cambridge Archaeological Journal*, *23*(1), 113–128. https://doi.org/10.1017/S0959774313000085

Tylén, K., Fusaroli, R., Rojo, S., Heimann, K., Fay, N., Johannsen, N. N., Riede, F., & Lombard, M. (2020). The evolution of early symbolic behavior in Homo sapiens. *Proceedings of the National Academy of Sciences*, *117*(9), 4578–4584. https://doi.org/10.1073/pnas.1910880117

Widianto, H. (2006). Dari Pithecanthropus Ke Homo Erectus: Situs, Stratigrafi, dan Pertanggalan Temuan Fosil Manusia di Indonesia. *Berkala Arkeologi*, *26*(2), 114–129. https://doi.org/10.30883/jba.v26i2.936

Widianto, H., & Noerwidi, S. (2020). Saatnya Menengok ke Barat: Sebuah Interpretasi Baru Tentang Distribusi Temuan Homo Erectus di Jawa. *Berkala Arkeologi*, *40*(2), 153–178. https://doi.org/10.30883/jba.v40i2.598

Willoughby, P. R. (2009). From the Middle to the Later Stone Age in Eastern Africa. In *Sourcebook of Paleolithic Transitions* (pp. 301–314). Springer New York. https://doi.org/10.1007/978-0-387-76487-0_20

Wynn, T. (2002). Archaeology and cognitive evolution. *Behavioral and Brain Sciences*, *25*(3), 389–402. https://doi.org/10.1017/S0140525X02000079