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HUMAN ORIGINS, DISPERSAL AND ASSOCIATED ENVIRONMENTS: AN AFRICAN PERSPECTIVE

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Contents

Summary

Africa's position as the cradle of humanity is widely accepted, supported by rich fossil and archaeological discoveries from different parts of the continent. Drawing on the Out-of-Africa theory of human origins, this article provides a condensed narrative of the major milestones in human evolution and associated environmental settings. The underlying hypothesis is that changes in global climate played an important role in fueling early modern human origins and dispersals within and outside of Africa. As one will discover in this article, the history of humanity is a tale of small events that merged together into major milestones over a long span of time. There is an emerging consensus among scholars that the onset of variable global climate throughout the last 6 million years, particularly the repeated glacial and interglacial cycles in the last 2.5 million years, drove the evolution of the biological and behavioral traits that define the human lineage. As with our past, the futurity of humanity will likely hinge on future climate patterns.

1. Introduction

The question of human origins has remained at the center of philosophical and scientific curiosities for centuries. The core issues surrounding current research on human origins revolve around two major questions: a) when exactly did the human lineage appear, possessing its distinct modern cultural and biological traits; b) where- in which geographic region did humans first appear? The question whether the human lineage emerged in one place or in multiple regions of the world has been at the center of anthropological discussions since the inception of the *Theory of Evolution* in the 19th century (Darwin, 1859). For a long time, Europe was considered the birthplace of the "superior human race" as it was there that ancient civilizations were believed to have first started (now we know that human civilizations began in ancient Mesopotamia and Egypt, both located outside of Europe). This belief was at the backdrop of Europeans' mindset when they imposed slavery and colonial ruling over many indigenous peoples.

Currently, there are two competing theories regarding the geographic origins of humanity, namely the Out-of-Africa and Multiregional models. The Out-of-Africa theory posits that early modern humans first appeared in Africa between 200 and 150 kya, and subsequently dispersed to the rest of the world replacing preexisting archaic humans in each region (Stringer and McKie, 1996; Oppenheimer, 2004). The Multiregional theory (Thorne and Wolpoff, 1992; WolPoff et al., 1994) maintains that modern humans appeared simultaneously in separate regions from an ancestral **hominin** that originated in Africa, and later dispersed to Asia and Europe sometime between 1.8 and 1.0 Mya. There are some scholars who support the Out-of-Africa model, but they advocate for assimilation and admixture between African and Asian *Homo sapiens* (Eswaran et al., 2005). By and large, the current debate on human origins remains firmly centered on Africa.

Drawing on the Out-of-Africa theory of human origins, this article provides a condensed narrative of the major milestones in human evolution and associated environmental conditions. The underlying theoretical baseline is that, different climatic episodes prevailed during the evolution of our lineage, and that changes in global climate played an important role in fueling early modern human origins and dispersals within and outside of Africa (eg., Finlayson, 2005).

2. The African Record

2.1. Background

Africa was long known as the "Dark Continent," but in the words of historians Paul Bohannan and Philip Curtin (1995), the darkness was in the ignorance of the outside world, not in Africa. Charles Darwin was among the first thinkers to label Africa as the likely cradle of humanity. In one of his seminal books, *The Descent of Man* (1871), Darwin made the following remark about the geographic roots of our lineage:

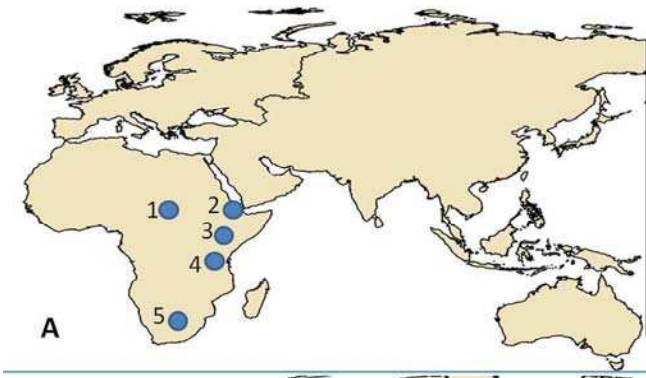
> "In each great region of the world the living mammals are closely related to the extinct species of the same region. It is therefore probably that Africa was formerly inhabited by extinct apes closely allied to the gorilla and chimpanzee; and as these two species are now man's nearest allies, it is somewhat more probable that our early progenitors lived on the African continent than elsewhere" (p.191).

By this statement, Darwin had foreshadowed important realities about the roots of humanity. A noteworthy insight was that humans are a single species that descended from an ape ancestor. This claim has been firmly established in the last century after genetic studies have revealed that humans and the African great apes are genetically close relatives (example: chimpanzees and humans are about 98% genetically similar). In Darwin's time, not much was known about genetics, and only a couple of hominin fossils had been identified, but his ingenious predictions had laid the foundations of our current views about human origins and diversity. Nowadays, Africa's place as the cradle of humanity is widely accepted, supported by archaeological and fossil discoveries from various parts of the continent.

2.2. Fossil and Archaeological Perspectives

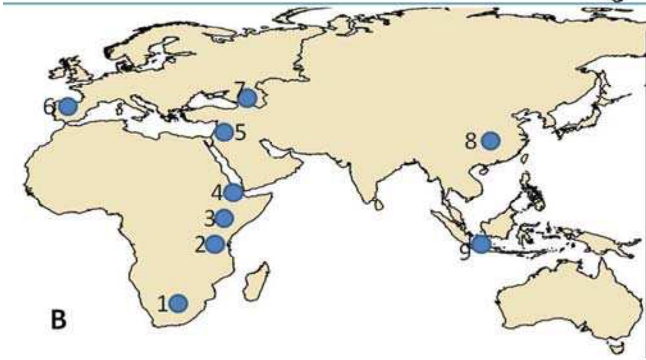
Some of the leading fossil discoveries that placed Africa at the center of human evolutionary research have come from eastern, southern and central parts of the continent. Fossil remains belonging to one of the earliest hominin lineages, collectively known as the Australopithecines, were first reported from South Africa in the 1920s (Dart 1925). Soon after, East Africa became the focus of intensive research on human prehistory, resulting in the discovery of numerous famous fossil hominins and the oldest stone tools. Amongst the many fossils identified are the following: the famous fossil known as *Australopithecus afarensis* or Lucy (~3.3 Mya), *Ardipithecus ramidus* or Ardi (4.4 Mya), *Australopithecus anamensis (*4.2 Mya), *Australopithecus boisei* or Zinj (2.3 Mya) and *Orrorin tugenensis* dated to ~6 Mya (Johanson and Edgar, 1996; Klein, 2009; White et al., 2009b). More recently, the world's oldest hominin fossil named *Sahelanthropus tchadensis* or Tumai has been discovered in the Chad region of central Africa (Brunet et al., 2002). Dated to 6–7 Mya, Tumai exhibits a flat cranial base, suggesting a tendency toward upright posture. Thus far, discoveries of such antiquity have only been made in Africa (Figure 1).

Since the 1960s, Africa has seen important fossil discoveries related to the genus *Homo.* The emergence of the genus *Homo* sometime between 2.5 and 2 Mya was an important chapter in human evolution, because most hominins that appeared prior to this time were more apes than humans in their overall characteristics. It was with the appearance of the genus *Homo* that the human line started to achieve major evolutionary changes toward the modern condition, such as expansion of the brain, superior cognition, and technological innovations, to name a few. Traditionally, the genus *Homo* is divided into three successive species, namely *Homo habilis*, *Homo erectus* and *Homo sapiens*, with two other loosely defined variants (*Homo heidelbergensis* and *Homo neanderthalensis*) placed between the latter two (Klein, 2009). The oldest member of the genus *Homo*, *H. habilis*, is believed to have evolved between 2.5 and 2 Mya in the Turkana Basin (northern Kenya) and Olduvai Gorge (Tanzania) regions of eastern Africa (Wood, 1987), at about the same time as the emergence of tool-making behavior (discussed below). Colloquially referred to as the "handy man", *H. habilis* is regarded as one of the potential hominins responsible for making the first stone tools. Around 1.9 Mya, not long after the appearance of *H. habilis, H. erectus* with its definitive human-like anatomy and behavior emerged in Africa, and subsequently dispersed to Asia, where its remains have been discovered in southwest Asia and as far as China and Indonesia (Rightmire, 1993). Whether *H. erectus* directly evolved to *H. sapiens* or if other intermediate species existed between the two remains a contested topic. However, there is little contention about *H. erectus'* contribution to the human lineage.



Key

#	Locality	Hominin genus	Age (mya)
1	Toros Menalla	Sahelanthropus	7 – 6
2	Middle Awash	Ardipithecus	4.4
2	Hadar	Australopithecus	3.3
3	Tugen Hills	Orrorin	6.0
3	Lake Turkana	Australopithecus	4.2
3	Lake Turkana	Homo	2.3
4	Olduvai Gorge	Australopithecus	2.4
5	Cradle of humankind	Australopithecus	2.3



Key

#	Locality	Hominin genus	Age (mya)
1	Cradle of humankind	Australopithecus	1.8
2	Olduvai Gorge	Homo	1.2
3	Lake Turkana	Homo	1.8
4	Buia	Homo	1.0
5	Ubeidiya	??	1.4
6	Atapuerca	Homo	0.7
7	Dmanisi	Homo	1.7
8	Zhoukodian	Homo	0.7
9	Java	Homo	1.6

Figure 1. Map showing representative hominin fossil localities older than 0.5 Mya: A) hominin localities in Africa older than 2.0 Mya, B) hominin localities in Africa and Eurasia dating between 2.0 and 0.5 Mya. Note that all sites older than 2.0 Mya are found in Africa. Site information: Klein, 2009, Figures 4.4–4.6, 5.5, Table 4.7, and references therein. Map template source: ESRI © worlddata, drawn by A. Beyin.

The world's oldest *Homo sapiens* fossil remains have come from two sites in Ethiopia, namely Omo Kibish and Herto, dating to ~195 kya and 160 kya respectively (Leakey, 1969; White et al., 2003; McDougall et al., 2005). Tanzania, Kenya, South Africa and the Nile Valley have yielded equally important cultural and fossil evidence belonging to early modern humans, demonstrating that *H. sapiens* occupied a wider geographic range within the continent. According to the Out-of-Africa origin theory, members of the genus *Homo* had already settled in Asia and Europe prior to 200 kya, but only the African "archaic" *H. sapiens*, possibly populations represented by the Omo Kibish and Herto specimens, are believed to have evolved into modern humans.

Africa is also regarded as the birthplace of human culture. So far the oldest intentionally made stone tools have been recorded at East African sites, such as Gona (2.5 Mya, Ethiopia), Lokosalie (2.4 Mya, Kenya) and Olduvai Gorge (1.8 Mya, Tanzania) to name a few (Leakey, 1975; Semaw et al., 1997; Delagnes and Roche, 2005).Generally, most sites that date to younger than 2.5 Mya in Africa contain stone tool assemblages, making stone tool technology the longest-lived cultural innovation. Among other things, the oldest assemblages from African sites show evidence of sequential-decision making, involving selection of high quality raw material and employing consistent methods of flake removal from the original nodule (Delagnes and Roche, 2005; Barham and Mitchell, 2008). All these seemingly simple chains of events are thought to have involved changes in the hand morphology (to allow power and precision grip), planning, and social communities that can facilitate retention and transmission of technical skills. The overall pattern in the development of stone technology is that general purpose tools, referred to as choppers and handaxes, persisted for more than 2.0 million years after the initial appearance of tool-making behavior around 2.5 Mya (Barham and Mitchell, 2008). After 500 kya, specialized tools, such as projectile points and composite tools entered the human cultural spectrum.

2.3. Genetic Perspectives

In the second half of the 20th century, a significant number of anthropologists turned their attention to molecular genetics (**DNA** sequence) to resolve outstanding issues concerning the geographic and temporal origins of humanity. The leading assumption is that genetic similarities between species are due to shared descent. As such, species that share a recent common ancestor are expected to display greater genetic similarity than those that are more distantly related. Interestingly enough, the genetic make-ups of modern humans and that of the African great apes, specifically chimpanzees and bonobos, display about 98% similarity. On the basis of this figure, the date for hominin-chimpanzee split from the common ancestor is estimated between 8 and 6 Mya (Langergrabera et al., 2012). This finding has corroborated what Darwin had posited a century ago, when he stated that “it is somewhat more probable that our early progenitors lived on the African continent than elsewhere” (Darwin, 1871:191).

In recent years, mitochondrial deoxyribonucleic acid (mtDNA) has been a particularly useful tool for addressing important questions about human origins and prehistoric migrations (Forster, 2004; Pakendorf and Stoneking, 2005). Mitochondria are small organelles found inside the cytoplasm of the cell, but are located outside of the nucleus. They are responsible for supplying the cell with energy, and they have their own DNA primarily inherited from the mother. In the sperm they are stored in the tail; however, the tail (along with its mtDNA) is quickly destroyed upon entering the egg during fertilization. The mode of inheritance makes mtDNA suitable for reconstructing human genealogy along the maternal line. According to the current mtDNA data, the ancestral “Mother” to all modern humans appeared first in Africa sometime between 200 and 150 kya, and that African populations display greater genetic diversity implying that Africa was populated by human ancestors longer than any other region (Cann, 1988). Among other things, the genetic data has reinforced the Out-of-Africa origin theory and set possible scenarios for human dispersals out of Africa. Moreover, comparison of intra-population (within population) genetic diversity between modern humans and the great apes has shown that modern humans display lower intra-population genetic variability than the great apes, suggesting that all modern humans share a recently evolved ancestral DNA.

The main story anthropologists have so far put together using the genetic data is that, sometime between 80 and 65 kya, a genetically distinct human lineage carrying a mtDNA **haplotype** known as L3 migrated from east Africa into Arabia via the southern Red Sea. Soon after, descendants of this population launched northward and eastward dispersals from the Arabian Peninsula (Forster, 2004; Forster and Matsumura, 2005; Macaulay et al., 2005). This means that all contemporary non-African humans have descended from one African lineage (represented by haplogroup L3), which later split into two founding lineages known as M and N haplogroups (see Figure 5C). The age of haplogroup L3 is estimated to be ~ 85 kya and that of haplogroups M and N ~ 63 kya (Macaulay et al., 2005; Torroni et al., 2006). The two descendant haplogroups have somewhat distinct geographic distribution with the M lineages mainly concentrated in eastern African, South Arabian, Indian, and southeast Asian populations, whereas descendants of haplogroup N are mainly found in western and central Eurasia (Forster, 2004; Cabrera et al., 2009). The fact that there exists a close genetic similarity among human groups occupying different regions of the world today suggests that we all share a recent common ancestor. This means *Homo sapiens* is a young species by evolutionary standards.

3. Environmental Framework for the Origins of Humanity

As the sole foundation of life supporting systems, the natural environment (climate, landscape and associated biomass) represents an ideal context for assessing the forces that spurred human evolution and diversity. Since the publication of Charles Darwin's legendary volume, "*The Origin of Species by Means of Natural Selection*" (1859), there has been a growing recognition of the close links between the process of species evolution, and global environmental and climatic changes. At the center of Darwin's theory lies the notion that "**Natural Selection**" enhances the survival of those species that are able to adapt to their habitats, by virtue of possessing favorable traits. The history of humanity is about those moments when our ancestors acquired decisive traits that enabled them to successfully adapt to diverse environmental conditions to which they were exposed at different times and places.

Looking at how the earth's landmasses are distributed with respect to the equator, one can discern that there is more dry-land in the northern hemisphere than the southern hemisphere (Figure 2). This means that, for terrestrial species, such as humans, the northern hemisphere offers more available habitats. However, since a large part of the northern hemisphere's landmass also lies in the temperate and polar zones, the region is sensitive to variation in solar radiation.

At times when the earth was receiving low solar radiation, extreme cold and dry conditions would prevail across most regions that lie farther north of the equator, causing terrestrial species there to become extinct or be replaced by cold tolerant species. This happened more frequently in the past 2.5 million years due to long term fluctuations in the earth's orbit between circular to elliptical forms, affecting the amount of solar radiation received by the earth. The tropical regions, which account for about 75% of the African landmass, would have been less subject to extreme climatic fluctuations. Therefore, at times when the global climate was growing cooler and drier, habitats that lie within the tropical zone would have remained the most favorable/tolerable for terrestrial species, such as primates. It is for this reason that Africa is regarded as the likely place where our ape ancestors gradually evolved to modern human form without any major evolutionary gaps. In Eurasia (Europe and Asia together), the great apes and by extension hominins were likely subjected to multiple extinction events due to repeated cycles of cold episodes.

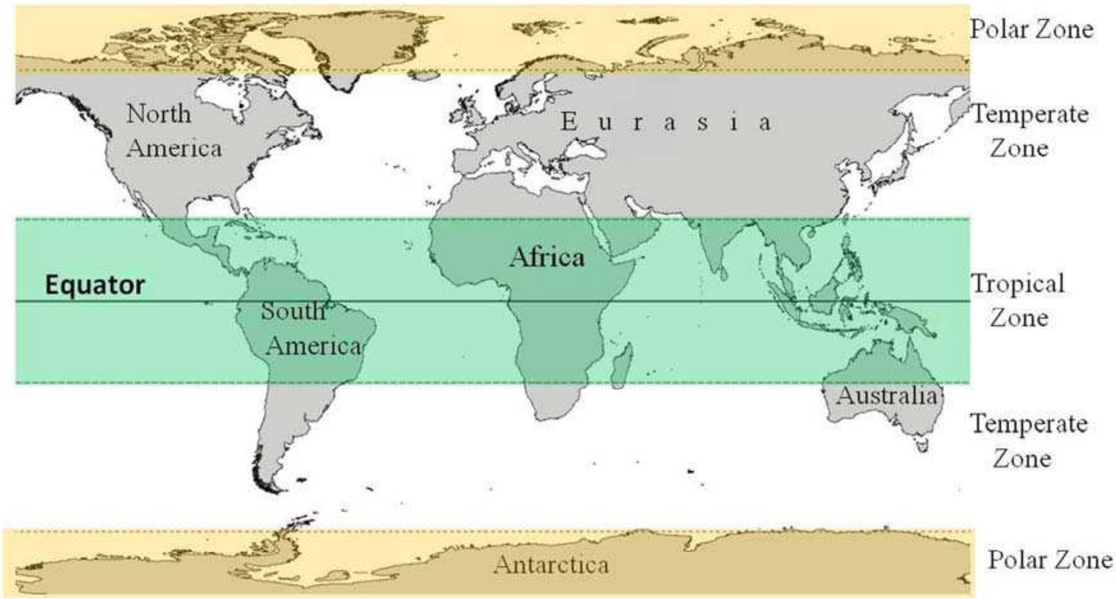


Figure 2. Map showing the major climate zones of the earth and landmass distribution with respect tothe equator. Note that the majority of the earth's landmasses lie north of the Equator. Regions most favorable for human life are found within the tropical zone, and this region saw the longest record of human settlement. Map template source: ESRI © worlddata, drawn by A. Beyin.

One may rightly ask, under what conditions did the defining characteristics of humanity evolve? At the present, there are two major hypotheses regarding the habitats that fostered the path to humanity, namely the "savanna hypothesis" (Laporte and Zihlman, 1983; Vrba et al., 1989) and the "variability selection hypothesis" (Potts, 1998). According to the savanna hypothesis, increased aridity and the emergence of savanna landscapes toward the end of the Miocene epoch (6 - 5 Mya) created a new survival dilemma for forest adapted apes. The dominant plants in the savanna are grasses, which are not readily edible by primates. To offset this dilemma, some primates may have switched to foraging on the ground. Under such a circumstance, bipedal walking may have emerged as an effective adaptation for energy conservation while foraging on the ground. Because only two limbs are engaged during bipedal locomotion, it costs less energy to walk on two limbs than on four.

The "variability selection" hypothesis emphasizes on the potential role of environmental instability in fostering the evolution of those characteristics unique to humans, such as bipedal walking, large brain and tool-making behavior. The underlying assumption is that environmental fluctuations in the last 6 million years compelled hominins to develop behaviors and anatomical structures responsive to varied habitat types (Potts and Sloan, 2010). In view of that, the expansion and contraction of forests *vis-a-vis* grasslands are thought to have stimulated the evolution of those crucial traits that lent humanity a decisive edge. One discovery of particular interest is a recently published 4.4 million years old hominin from Ethiopia called Ardi (White et al., 2009a). The local geology and associated fossils at the site suggest that Ardi lived in a predominantly forested habitat, thereby implying that grasslands may not have always been the primary environment where hominins thrived as is commonly perceived. For some time, a minority group of scholars have advocated for an aquatic origin of humanity (Morgan, 1982; Verhaegen, 2013). Dubbed the "Aquatic Ape Theory", the proponents of this idea claim that the human lineage went through an aquatic stage during the transition from the last common ancestor we shared with other hominins, citing some anatomical features and behaviors believed to be present in humans and aquatic mammals only, such as loss of body hair, skin-bonded fat deposits, and ventro-ventral copulation. Currently, the theory remains largely ignored by mainstream anthropology for a lack of supporting **paleoenviornmental** and fossil data (Foley and Lahr, 2014).

Researchers utilize a wide-range of methods to reconstruct past climate and environments in an attempt to assess the potential effects of habitat variability to human evolution and survival. One of the well established approaches for reconstructing past climate changes involves analysis of oxygen **isotope** variation (^{16}O vs ^{18}O) from deep-sea cores (Shackleton, 1967). The underlying assumptions of this approach are that evaporated water is rich in the lighter oxygen isotope (^{16}O), and that during glacial times more evaporated water is trapped in the polar ice sheets, causing sea levels to drop several meters below their present height. This phenomenon leaves the ocean waters rich in the heavy oxygen isotope (^{18}O). Long columns of deep-sea sediments are cored, from which ocean-dwelling organisms called foraminifera are extracted. The oxygen isotope contents of the foraminifera are then examined, and the results are translated to global climate patterns. For example, oceanic foraminifera rich in ^{18}O would translate to cold conditions, because during such episodes the marine organisms will incorporate more of the heavy oxygen as the lighter isotope would remain trapped in the polar ice sheets. Conversely, oceanic foraminifera representing interglacial episodes (associated with warm conditions, accompanied by ice melting) contain higher proportion of ^{16}O. Patterns of past climate changes have also been determined using terrestrial deposits and from proxy sources, such as lake deposits, analyses of dental and bone chemistry of animals that thrived in the past, and **palynology**. All of these methods are shedding new light on the environmental contexts that framed human evolution and dispersal.

Paleoenvironmental data derived from marine and terrestrial settings show that Africa had seen dramatic fluctuations in climate in the past 3 million years, compelling hominins to be adaptive and competitive (Barham and Mitchell, 2008). Successive cycles of glaciation and deglaciation prevailed throughout most of the Pleistocene epoch (2.5 Mya - 12 kya). Some of the climatic pulses were abrupt, others occurred after long intervals. Prior to 0.9 Mya, the glacial cycles lasted for shorter periods (~ 40,000 years). Whereas after 0.9 Mya, the glacial intervals lasted much longer (about 120,000 years) while interglacial cycles were shorter in duration (Muller and MacDonald, 1997). Citing the paleoclimatic record of Africa (deMenocal, 1995), Barham and Mitchell (2008) mention rapid climatic changes at 2.8, 1.7 and 1.0 Mya. Repeated and intense ice ages hit the world in the subsequent periods, with the last one (the Last Glacial Maximum) dating between 25 and 22 kya. The potential effects of such repeated cycles of glacial and interglacial episodes may have included the contraction and expansion of habitats suitable for hominin adaptation.

Glacial episodes are thought to have created harsher conditions for hominins in higher latitudes (much of Europe and Asia). In this regard, Klein (2009: 272) notes that, "the impact of climate change 6 - 5 Mya is most obvious in Eurasia and North America, where the large majority of mammalian genera that existed before 6 Mya were lost or replaced by others by about 5 Mya", thereby implying that the apes that inhabited much of Eurasia before 6 Mya may not have contributed to the evolution of the human lineage, making Africa the likely ancestral homeland where one of the Miocene apes evolved to early bipedal hominins, and one of those hominins gave rise to modern humans. In the tropics, a long-term trend towards arid and more open habitat coincided with glacial episodes. Consequently, some hominins may have been pushed to new territories, others subjected to extinction and some others managed to survive by developing new biological and cultural adaptations.

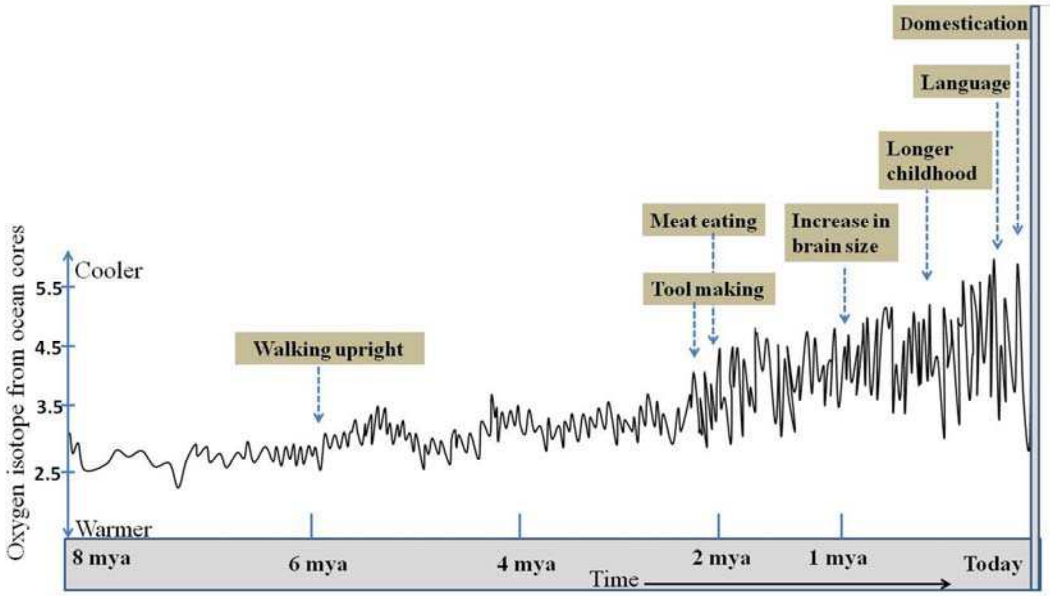


Figure 3. Diagram showing worldwide climate pattern in the last 6 million years derived from oxygen isotope analyses, and associated milestones in human evolution. Oxygen isotope graph redrawn from Potts and Sloan, 2010:48.

As shown in Figure 3, there was a close link between major environmental pulses and the emergence of different hominin species in the last 6 Mya. In this regard, Klein (2009: 272) notes that "of the three basal hominins that are proposed from between 7 and 5 Mya, two - *Sahelanthropus tchadensis* and *Orrorin tugenensis* - lived (or died) with other animals that indicate savanna-like conditions nearby." On a related topic, the same author explains "... in the interval when bipedalism emerged - between 8 and 5 Mya - global climate was growing cooler and drier" (p. 271). The so-called "age of humanity", the Pleistocene epoch saw the evolution and diversification of the genus *Australopithecus* into a range of loosely defined lineages (Boisei, Robustus, Aethiopicus,etc), and the emergence of the genus *Homo* along with its defining characteristics, including tall and slender stature, and large brain. As stated above, the oldest intentionally crafted tools (in the form of general purpose stone implements) have come from deposits dated to about 2.5 Mya from the Gona region of Ethiopia. Concurrently, this was a period of rapid explosion of savanna-adapted herbivore fauna in East Africa (Vrba, 1985). The emergence of *Homo erectus*, one of the first undisputed representatives of the genus *Homo*, is believed to have coincided with the onset of rapid changes in African climate between 2 and 1.6 Mya (Barham and Mitchell, 2008). As the global climate grew more unstable and variable - fluctuating between prolonged glacial episodes and shorter interglacial phases toward the end of the Pleistocene (200 - 10 kya), humans needed to develop flexible adaptation. Ultimately, in pursuit of better survival opportunities, our lineage emerged as the most imaginative species.

4. The Path to Humanity and Related Milestones

For a long time, human evolution was perceived as a linear progression from ape-like primitive ancestors to modern humans. In this sense, apes were placed at the bottom and modern humans on the top of the evolutionary ladder, with successive hominin species filling the time-line in between. The current fossil data shows that the path to humanity involved a series of adaptive radiations, whereby at multiple occasions several hominin forms lived side by side. Eventually one of these varieties evolved to modern humans. For example, the fossil record shows that at least three hominins (*Australopithecus boisei*, *Homo habilis* and *Homo rudolfensis*) overlapped in time and space in East Africa between 3 and 2 Mya (Klein, 2009). The scenario represents one case in point among many other evolutionary riddles that have intrigued researchers for decades. The first hominin to exhibit human-like anatomy and behavior was *Homo erectus*, believed to have first emerged in Africa around 1.9 Mya and subsequently dispersed to Eurasia (Rightmire, 1993). Known for making elaborate stone tools called handaxes and controlled use of fire, *H. erectus* possessed a large brain, and a fully-erect and slender body, well-suited to long distance foraging in varied environments. Whether *H. erectus* directly evolved to *H. sapiens* or if other intermediate species existed between the two remains unclear. However, there is little contention about *H. erectus'* contribution to the human lineage. What follows is a brief review of the major milestones that shaped the path to humanity.

One of the central questions in human evolution concerns the identification of the first humans in the fossil record, in other words, what criteria do/should anthropologists employ to distinguish the first true humans from the many other hominins that evolved in Africa at different times? While there are no all-encompassing standards to distinguish the first true humans in the fossil record, anthropologists have compiled a list of trends (shown in table 1), that continue to serve as potential checkmarks to distinguish the true human line from other hominins whose fate remains less well understood.

By far, one of the most crucial milestones in human evolution was the emergence of bipedal posture (walking on two legs). While the contribution of bipedalism in enhancing the reproductive success of our ancestors is widely recognized, the causes for the emergence of this trait remain unresolved. Thus far, more than 30 hypotheses have been proposed to explain the evolution of upright walking in hominins (Niemitz, 2010). It is likely the case that bipedal walking emerged as a viable adaptation in response to the expansion of grassland habitats at the end of the Miocene - early Pliocene span (6 - 5 Mya). With the dwindling of forests, the apes that developed bipedal adaptation may have found walking on two legs advantageous for foraging and hunting on the ground. Bipedalism has freed the hands, and with free hands our ancestors (and now we) are able to carry weapons, food and infants for longer distances, as well as throw weapons toward potential prey with greater accuracy. Free hands combined with tool use would have made it easier to gain access to high quality foods, such as meat and underground stored plant resources (Barham and Mitchell, 2008). Also, vertical posture is believed to have improved our ancestors' visual surveillance (ability to spot predators or prey from afar) and endurance during long hours of hunting and foraging.

Defining traits of the human lineage	**Approximate time of first appearance**		**Geographic region first emerged**	**Earliest associated hominin species**
Bipedalism: walking on two feet	primitive version	7.0–5.0 mya	Africa	*S. tchadensis, O. tugenensis*
	developed version	1.8 mya	Africa	*H. erectus*
Smaller canine tooth	6.0–5.0 mya		Africa	*S. tchadensis*
Reliance on cultural inventions: tools	2.6 –2.0 mya		Africa	Australopithecines, *H. habilis*
Large brain size >600 cm^3	2.4 –1.5 mya		Africa	*H. habilis* *H. erectus*
Tall bodies, short guts	1.8 –1.5 mya		Africa	*H. erectus*
Controlled use of fire	1.5 –1 mya		Africa	*H. erectus*
Longer life span, rapid increase in brain size	after 0.5 mya		Africa, Eurasia	*H. erectus* *H. heidelbergensis* *H. sapiens*
Longer childhood	after 0.5 mya		Africa, Eurasia	*H. erectus* *H. heidelbergensis* *H. sapiens*
Globular cranial vault, vertical face	after 250 kya		Africa, Eurasia	*H. sapiens* *H. neanderthals*
Symbolic thoughts (language, art….etc)	after 250 kya		Africa, Eurasia	*H. sapiens* *H. neanderthals*
Agriculture and sedentary life	after 10 kya		Africa, Eurasia, the Americas	*H. sapiens*

Table 1. Hallmarks of humanity, probable dates of their first appearance and associated hominins. (Sources: Barham and Mitchell, 2008; Klein, 2009; Potts and Sloan, 2010).

Thermoregulation is regarded as another potential benefit of bipedalism (Wheeler, 1984). Vertical posture exposes a small part of the body to direct sunlight or to radiation reflected from the ground on the hot savanna, thus reducing the amount of excessive heat stress that could affect the body's metabolism, especially that of the brain. The evolution of a hairless body has also been attributed to an adaptation to hot and open savanna landscapes, whereby it may have become necessary for our ancestors to shed body hair so as to minimize the amount of solar radiation that could be trapped in the blazing hot savanna. With a naked body, hominins would be able to easily dissipate body heat through sweat. This would have made it easier to hunt at mid-day, at which point most terrestrial prey species could easily get exhausted if chased for a reasonable distance. All of these benefits could have enhanced hominin survival in an open savanna habitat, where both hunting and gathering would have required covering long distances and endurance. Gradually, a fully developed bipedal posture may have fueled the development of other crucial human traits, such as a large brain and technology.

While bipedal walking remained the main feature that distinguished hominins from other apes for a long time, the advent of technology around 2.5 Mya had likely accelerated the pace of human evolution. The question of which hominin group made the earliest stone tools remains unresolved, but the expansion of vast savanna habitat between 3 and 2.5 Mya is believed to have stimulated tool-making behavior (Barham and Mitchell, 2008). Habitat instability may have forced hominins to be inventive, thereby prompting cultural solutions to ecological hardships. As forests dwindled, vegetal feeding strategy (eating fruits and leaves) must have become less dependable, forcing hominins to incorporate meat in their diet. Frequent encounters with animals killed on the landscape would have compelled hominins to devise a means enabling them to separate meat from the carcass. The invention of stone tools is thought to have made it easier for meat to be transported to a safe place where it could be shared among group members. Another crucial invention that had far reaching implications in enhancing early human evolutionary fortune was the invention of fire. *Homo erectus* is often credited for the earliest controlled use of fire, beginning around 1.5 Mya in Africa (ibid.). With the invention of fire, *H. erectus* and its descendants attained access to cooked food, which facilitated rapid digestion and efficient use of nutrients by the body, particularly in the brain. In addition to contributing to brain development, cooking and other activities around the fire may have promoted social bonding (groups that can share food, cooperate, and share technical skills) and intimacy among potential mates.

Following bipedalism and the inception of tool-making behavior, the next crucial milestone in the evolution of our lineage involved the expansion of the brain. Hominin brain size has increased almost threefold in the last 2.5 million years. In other words, for the first 4.0 million years after the human lineage split from the common ancestor with chimpanzee, the hominin brain size remained more or less comparable to that of the great apes. Yet, the questions of when and how our ancestral hominin gained larger brain size have not been satisfactorily answered. At the outset, tracking the evolution of the brain is confounded by poor preservation of the brain's soft tissues in the fossil record. The earliest-known hominin to experience a dramatic brain size increase was the genus *Homo*, specifically *H. erectus*. By about 1.5 Mya, the brain of the genus *Homo* had increased by at least 80% compared to 3.0 million-year old *A. afarensis* (ibid.:106). Having acquired a remarkable increase in brain size, *H. erectus* fabricated advanced tools known as handaxes, made controlled use of fire and consumed a high quality diet, including meat and bone marrow. Moreover, *H. erectus* is believed to have acquired a narrow physique and a shorter digestive tract, making efficient running and walking for long distances possible. The shortening of the gut is thought to have been achieved as hominins started to eat high quality diet (meat) as opposed to bulky vegetal food (leaves, tubers), which would require a longer gut. All of these advances must have greatly enhanced *H. erectus'* survival fitness in varied habitats.

The enlargement of the brain is thought to have accelerated the evolution of complex symbolic thoughts (language, art and belief) and technological inventions that continued to facilitate human survival anywhere they went. As rightly stated by Potts and Sloan (2010:100), "the human brain is the source of intellect and insanity, creativity and cruelty. It is the place where the powers of belief, reasoning and emotion meet in a compact universe of a hundred billion firing neurons." By and large, it is this quality that continues to lend us a competitive edge over the immense forces of nature.

5. The Role of Dispersal in Human Evolution

Today, humans are among the most successful species in terms of inhabiting broad geographical expanses. Presently, there is no continent on earth that lacks human traces, and we are about to embark on occupying other planets. Throughout history, dispersal has remained an important part of human pursuit as a prime mover of people, genes, cultural innovations, traditions and languages across different parts of the globe (Bellwood, 2013). From an evolutionary standpoint, dispersal can be regarded as a form of adaptive response to adversity (environmental calamity, population pressure, diseases, and so on). By moving to new habitats, hominins and other species create new survival opportunities. Every time our ancestors faced adversity, they were often left with two choices- develop new adaptive strategies (through biological or cultural means) or migrate to new habitats. If neither was executed successfully, extinction was the inevitable fate. These choices still underpin human lives all over the world. To appreciate the importance of dispersal to human survival, one may ponder upon the ever-growing movement of people across continents and countries to earn their basic livelihood.

While the successful dispersal of early humans into all the major continents represents a remarkable evolutionary feat, the question of what specific conditions stimulated hominin migrations out of Africa (the ancestral homeland) remains less well understood. Researchers frequently cite climate change, population pressure, increased alliance network, projectile technology and the emergence of complex behaviors associated with the use of language and symbolism, as the likely causes that stimulated early human migrations out of Africa and beyond (Beyin, 2011 and references therein). However, determining the degree to which each of these variables played a role remains elusive given that some of the presumed causes of dispersal lack concrete archaeological traces (e.g., language, scale of population pressure), while cultural remains are often inconsistently represented across broad regions.

As outlined by Fagan and Duranni (2014), some of the potential factors that could have made dispersal a viable survival strategy in the case of hominins are, a) hominins walk bipedally- an efficient locomotion in an open savanna landscape, b) after 1.8 Mya, hominins possessed large-sized brains, which placed additional pressure on finding foods with the highest nutritional quality. As noted by Potts and Sloan (2010:107), humans have a very demanding brain that requires more energy than any other organ (the human brain makes up only 2% of the body weight, but consumes up to 25% of the body's energy). Citing anthropological studies that show that hunter-gatherers tend to live in scattered communities, and drawing on the fact that larger mammals are more mobile than their smaller relatives, Fagan and Duranni (2014) explain that, for emerging humans, wide territorial ranges, a high degree of mobility, and a broad dietary range may have become necessary survival pursuits. Eventually, repeated seasonal mobility in search of stable habitats and critical resources may have fueled hominin expansion out of Africa. In this regard, some scholars propose that the consumption of aquatic resources may have enhanced human evolutionary fortunes. A prominent biogeographer, Carl O. Sauer (1962), once referred to aquatic habitats as the "primitive home of man"; and he described their role in the following words: "our kind had its origins and earliest home in an interior land. However, the discovery of the sea, whenever it happened afforded a living beyond that. The sea, in particular the tidal shore, presented the best opportunity to eat, settle, increase and learn" (p. 45).

6. Tracking Early Human Dispersal Routes out of Africa

Granted that early humans first appeared in Africa, the question of how they dispersed out of Africa remains unresolved. This section provides a brief review of the main dispersal routes for early humans out of Africa. For a comprehensive review of current assumptions and debates about the history of human colonization of major continents, the reader is referred to a recent publication by Peter Bellwood (2013), *First Migrants: Ancient Migration in Global Perspective.*

Currently, there are two main proposed routes for early human dispersals out of Africa. These are the Northern Route (NR), which proposes northward migration of early humans from eastern Africa to southwest Asia (the Levant) via the Nile Corridor (Tchernov, 1992; Van Peer, 1998); and the Southern Route (SR), which proposes a direct route from Africa to Arabia via the Strait of Bab al Mandab, at the southern end of the Red Sea (Lahr and Foley, 1994; Macaulay et al., 2005; Beyin, 2006), Figure 4. Whether both migration routes were equally preferable or accessible to early humans remains unclear. However, considering environmental barriers associated with the aridity of the Sahara Desert, the NR route was most likely preferred during wetter climatic conditions (Beyin, 2006). At times when the Sahara and the Nile corridor posed a risk to human expansion, the SR may have served as an alternative gateway of biographic movements between Africa and Eurasia.

Outside of the two major routes discussed above, two other potential gateways of biographic movements may have existed between Africa and southwest Asia: one through central Sahara to North Africa (Osborne et al., 2008), and the other along the western coastal margins of the Red Sea basin (Kingdon, 1993; Stringer, 2000), Figure 4. Using geochemical data from **wadis** and by locating several fossil river channels in the Libyan Desert, a group of researchers led by Anne Osborne of University of Bristol has demonstrated that humid corridors existed through the central Sahara during the Last

Interglacial, specifically during the period 130 - 117 kya (Osborne et al., 2008). A less well explored but vital region in assessing early human dispersal routes out of Africa is the western coastal strip of the Red Sea. Due to its proximity to the Nile Valley (a widely accepted dispersal route) and the Sahara desert (one of the harshest expanses of land), the western coastal landscape of the Red Sea would have remained a *de facto* dispersal artery for hominins trying to expand their niche outside of the Nile basin or from eastern Africa in response to climate changes or to demographic pressure.

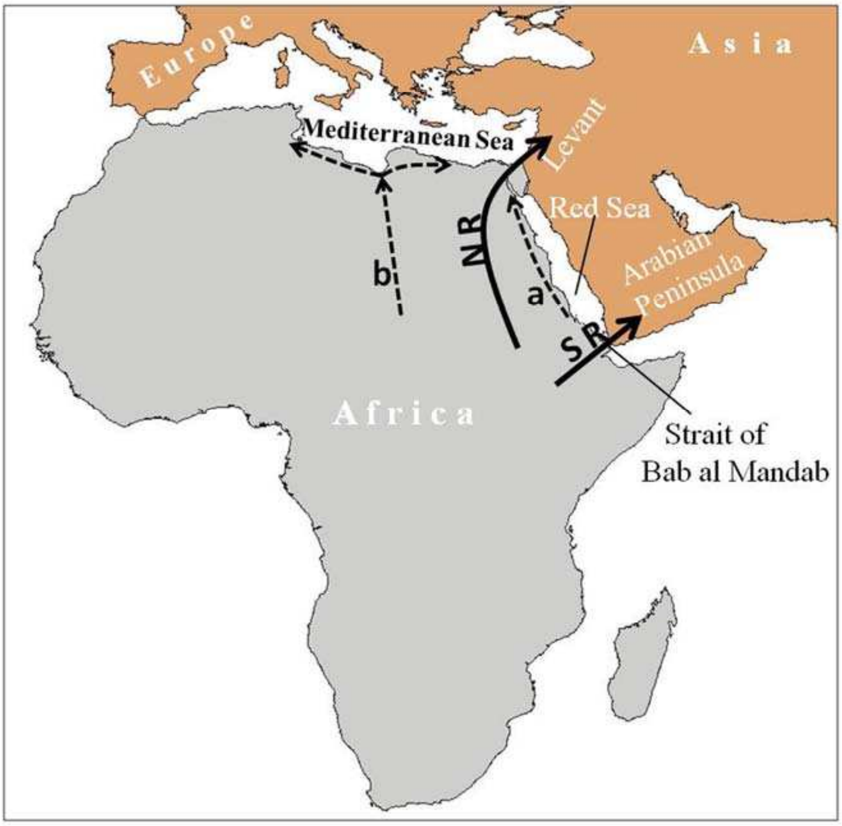


Figure 4. Map showing the major proposed dispersal routes out of Africa. Key: NR = Northern Route, SR = Southern Route, a = Coastal route along the western peripheries of the Red Sea, b = the Sahara Corridor. Map template source: ESRI © worlddata, drawn by A. Beyin.

There is a growing consensus among researchers that human dispersals toward southeast Asia, and ultimately to Australia and the Americas were accomplished by means of coastal routes (Bellwood, 2013; and references therein). This view has long been expressed by Carl O. Sauer, who categorically referred to the seashores as the "primitive home of man" and a conduit for early human migrations (Sauer, 1962). Sauer's idea was later adopted by a prominent biogeographer, Jonathan Kingdon, who proposed a circum-Indian Ocean coastal dispersal for early humans (Kingdon, 1993). According to Kingdon, the main prerequisites to human dispersal out of Africa were adaptation to coastal environments and raft building technology. Due to its strategic location at the nexus of northeast Africa, the Arabian Peninsula, and southwest Asia, the Red Sea basin is regarded as one of the most plausible conduits for early human coastal migration out of Africa (Stringer, 2000; Walter et al., 2000; Bailey, 2009; Beyin, 2013). Like many other water bodies, the Red Sea saw a considerable decrease in its water-level during the major ice ages, resulting in the formation of extensive coastal plains along the African and Arabian sides (Lambeck et al., 2011). While our knowledge of early human settlement history along the Red Sea basin remains sparse due to inadequate fieldwork in the past, the few coastal sites known from Eritrea in recent years (Walter et al., 2000; Beyin, 2013) signify that the coastal territories of Eritrea, Djibouti and Somalia may have been frequently inhabited by hominins who served as founder populations for later dispersals into Arabia and southwest Asia.

The main support for coastal dispersal of early humans out of Africa comes from genetic data related to some east African and southeast Asian indigenous populations. Accordingly, it has been proposed that a small group of East African population had launched an eastward rapid coastal dispersal through the SR sometime between 80 and 60 kya (Oppenheimer, 2004; Macaulay et al., 2005). Early humans might have crossed the Red Sea basin using watercrafts or by temporary land bridges formed during low sea level events corresponding to major ice ages. Conceivably, prior to launching an eastward or northward dispersal from the Arabia Peninsula, early humans must have exploited the coastal margins and some of the well-drained interior landscapes of central Arabia, when climate conditions permitted.

7. Paleoclimatic Perspectives on Early Human Dispersals out of Africa

The effects of past climate changes on the origin and dispersal of early humans have long been recognized (Potts, 1996; Forster, 2004; Finlayson, 2005; Carto et al., 2009). Early humans along with many other mammalian species are thought to have contracted and expanded their territorial range in response to climate changes. Among the most evident effects of climate change include changes in the distribution and nature of food resources available for hominins (Barham and Mitchell, 2008). To a great extent, dispersal (in hominins and other animals) can be regarded as a climate controlled survival mechanism, whereby species move from one habitat to another in search of favorable habitats once local resources become scarce. In his recent review of the biogeography and evolution of the genus *Homo*, Finlayson (2005: 457) categorically argued that "climate-driven ecological change has been, as with many other taxa, the driving force in the geographic range dynamics of the genus *Homo*."

The period associated with the origin and dispersals of the human lineage saw recurrent glacial events that caused prolonged dry and cold conditions globally. Two such events occurred in the range of 180 - 125 kya, and 75 - 60 kya, respectively (Tripsanas et al., 2006; Parker, 2009). Potential adaptive responses to climatic aridity may include migration, population fragmentation, and subsistence on low rank resources (Beyin 2011 and references therein). Prolonged episodes of arid conditions are thought to have fueled dispersals, because when local habitats deteriorate hominins would be forced to disperse in search of favorable/vacant habitats. On the basis of past global climate simulation data, Carto and colleagues (2009) reported that "**Heinrich event**s, which occurred episodically throughout the **last glacial cycle**, led to abrupt changes in climate that may have rendered large parts of North, East, and West Africa unsuitable for hominin occupation, thus compelling early *Homo sapiens* to migrate out of Africa" (p.140).

During glacial times, when a vast amount of freshwater was locked up in the polar ice sheets, sea levels would have dropped considerably, creating vast coastal territories that could have served as potential **refugia** and conduits of population movement (Faure et al., 2002). Coastal margins may have been magnets for human habitation when sea levels were low due to the formation of freshwater springs along the newly exposed coastal gradients. According to a recently proposed Coastal Oasis model (Faure et al., 2002), the flow of groundwater along the coastal gradients increases when sea levels drop during ice ages. In this regard, human crossing of the Red Sea into the Arabian Peninsula is believed to have been partly facilitated by the existence of such broad coastal landscapes featuring freshwater oases and a narrow strait along the Bab al Mandab during periods of low sea level. Once they entered Arabia, early humans may have continued spreading northward into southwest Asia along the eastern strip of the Red Sea and eastward along the northern coastal peripheries of the Indian Ocean up to the Persian Gulf and farther east into India, China, Indonesia and Australia, taking advantage of potential freshwater oases and **estuaries**. Human movement along these coastal margins may have been faster and safer because once humans adapted to one coastal territory, there was little need to devise new technology to exploit another coastal habitat (Bulbeck, 2007).

As a landmass strategically located adjacent to Africa, the Arabian Peninsula stands out as an important region in discussions about prehistoric human dispersals out of Africa. With its mainly flat terrain that could easily turn into a swath of savanna landscape during wet conditions, the Arabian Peninsula may have been a magnet for prehistoric human habitation and a viable migration corridor between Africa and Eurasia (Rose, 2006). A recent discovery of numerous Stone Age sites in central Arabia suggests at least intermittent incursions of prehistoric hunter-gatherer groups into the interior of the Peninsula during periods of climatic amelioration (Crassard and Hilbert, 2013). Regarding early human settlement history in Arabia, Jeffrey Rose of Ronin Institute has recently formulated a tantalizing model dubbed "the Gulf Oasis", which proposes that early modern humans were able to survive periodic hyperarid oscillations by contracting into coastal refugia around the Peninsula (Rose, 2010). In view of that, the author hypothesizes that the Persian Gulf may have served as a refugium and source area for human diffusion to eastern and western Asia.

In light of the reviewed literature, no single factor appears to have been responsible for stimulating human dispersal out of Africa. For some researchers, the expansion of lush savanna landscapes during wet episodes appeals as the most viable conditions for early human territorial range expansion. For instance, Rose (2006), in formulating his "Arabian Corridor Migration Model", linked human dispersals into Arabia with the expansion of lush savanna habitats during wet conditions. For others, the onset of dry conditions is regarded as the likely scenario that stimulated early human dispersals in search of favorable habitats (Carto et al., 2009). Such being the case, identifying a single cause or trying to establish a universal model for early human dispersals is problematical because dispersal is not a uniquely human phenomenon. Numerous mammalian species (e.g., many ancestors of present day carnivores, elephants and monkeys) have moved back and forth between Africa and Eurasia in the past (Lewis and Werdelin, 2010; Martinez-Navarro, 2010).. Therefore, the same forces that fueled dispersals in other organisms may have stimulated early modern human migrations out of Africa. In a nutshell, human dispersals out of Africa may have occurred many times in response to ecological pressures or to **autocatalytic** factors, whereby the discovery of new attractive areas led to the expectation of more vacant habitats (Keegan and Diamond, 1987). Like many other survival strategies, human dispersal must have involved a complex interplay of natural instincts and conscious decisions.

8. Early Human Dispersal Episodes Out of Africa

8.1. Overview

Archaeological and fossil data show that hominins left Africa multiple times, but the question of which among those dispersals was successful in terms of forming viable founder populations in Eurasia has not been satisfactorily answered. Essentially, inferring dispersal events from the fossil record is confounded by preservation and research biases. For one, some of the crucial regions to assessing early human dispersal out of Africa (e.g., the western and eastern coastal strips of the Red Sea basin) have remained neglected for a long time, thus our knowledge of the archaeological and fossil records of these regions is still limited. Without adequate research in the putative regions, it will be impossible to determine the temporal and geographic contexts of early human dispersal patterns out of Africa. Moreover, detecting prehistoric dispersal episodes can be problematical if the hypothetical origin and destination areas were continuously occupied by hominins. If, for example, early humans first entered the Arabian Peninsula ~ 1.0 Mya, and inhabited the region for the next half a million years, any researcher would find it difficult to demonstrate the presence or absence of subsequent dispersals from Africa into Arabia between 1.0 and 0.5 Mya, because the new arrivals and the preexisting ones may have blended culturally and genetically. That being the case, the working hypothesis here is that hominins left Africa many times. For the sake of brevity, three among the many likely out of Africa dispersal episodes are considered in this article (Figure 5A - C).

8.2. Out of Africa I (1.9 - 1.0 Mya, *Homo erectus*), Figure 5A

According to current fossil and archaeological evidence, the first hominin to leave Africa was *H. erectus,* with the initial dispersal believed to have commenced sometime between 1.9 and 1.7 Mya (Anton and Swisher, 2004). *Homo erectus* is often referred to as a global species, because its remains have been discovered in Africa, Asia and Europe. The general consensus is that prior to the appearance of *H. erectus* around 1.9 Mya, hominins remained restricted to Africa (Fleagle et al., 2010). There are some scholars who question this view, arguing that *H. erectus* may have appeared in Africa and Asia in parallel from preexisting hominins (Dennell and Roebroeks, 2005). However, no evidence of hominin occupations of Asia and Europe predating the genus *Homo* has yet been recorded. This leaves Africa as the only source of the *H. erectus* lineage that first colonized Asia and Europe. The oldest evidence of hominin presence in Eurasia has come from the site of Dmanisi, Georgia (in the Caucasus), dating to ~ 1.8 Mya (Gabunia and Vekua, 1995). Sometimes referred to as *Homo georgicus* by its discoverers, the Dmanisi group is generally treated as an offshoot of *H. erectus*. Other Erectus settlements have been reported from southwest Asia (Israel), India, and as far east as China and the Indonesian islands (Rightmire, 1993). Several of the sites preserve a range of stone tool assemblages (featuring handaxes and general purpose chopper tools) and evidence of controlled use of fire. *Homo erectus'* success in colonizing diverse environments is likely to have been facilitated by its cultural innovations (e.g., tools, fire and social bonding) and physiological adaptability.

Major climatic changes have been detected corresponding to this dispersal event. The period between 2.0 and 1.5 Mya saw repeated cycles of aridity, expansion of savanna habitat and marked rainfall seasonality, possibly forcing hominins to create new survival opportunities, including territorial expansion (Barham and Mitchell, 2008). The expansion of savanna habitat across Africa and Asia is thought to have permitted successful hominin dispersals, because hominins who evolved in African savanna would have encountered few barriers to movement into similar habitats in other regions. Most proponents of the Out-of-Africa origin theory maintain that successive waves of *H. erectus* may have dispersed into Eurasia, but their direct descendants in Europe and Asia did not make a meaningful contribution to modern human genetic makeup. The most likely scenario is that, the descendants of the Eurasian *H. erectus* went extinct amid repeated climatic cataclysms caused by recurrent ice ages that became intense after 1.0 Mya. As stated earlier, with the onset of ice ages, the distribution of plant and animal resources for hominins were more severely affected in Eurasia than in Africa. Under such conditions, early inhabitants of temperate regions may have been pushed to marginal landscapes where they eventually faced extinction.

8.3. Out of Africa II (130 - 100 kya, *Homo sapiens*), Figure 5B

This event is considered to be the earliest out of Africa dispersal attempt by *Homo sapiens* following its first appearance in eastern Africa 200 - 150 kya (Finlayson, 2005). The presence of a successful dispersal of early modern humans from Africa into southwest Asia during this time range is supported by the discovery of modern looking fossil remains from two cave sites in Israel (Jebel Qafzeh and Skhul), dating to between 130 and 90 kya (McCown and Keith, 1939). The NR along the Nile-Sinai had likely allowed human movement between northeast Africa and southwest Asia during this time. The discovery of archaeological assemblages dating to between 220 and 150 kya at the Sai Island, Nile Valley (Van Peer et al., 2003), hints at the African origin of the Qafzeh and Skhul populations. The absence of archaic *Homo sapiens* fossil remains predating this time in southwest Asia has ruled out the possibility of *in situ* (local) evolution for the Qafzeh and Skhul populations. Other tangential evidence in support of this dispersal comes from stone tool assemblages from Arabia, dated to between 127 and 90 kya (Armitage et al., 2011; Rose et al., 2011). The assemblages reveal strong resemblance with contemporaneous African finds, thereby suggesting an episode of successful hominin expansion into Arabia during this time. This dispersal event is believed to have coincided with the onset of an interglacial period (characterized by warm and wet global climate) around 130 kya, which created a lush savanna belt across eastern Africa and the adjacent regions, including Arabia and southwest Asia. Such a homogenous habitat zone likely promoted human movements between these regions.

The larger role that the Qafzeh and Skhul populations played in the ultimate peopling of Eurasia remains less well understood. Some scholars consider this dispersal as a temporary or a failed one (Finlayson, 2005; Mellars, 2006c). After the Qafzeh and Skhul populations, no modern human presence is known in southwest Asia until around 48 kya. This long gap in modern human re-appearance in southwest Asia may signify that after briefly inhabiting this area, the Qafzeh and Skhul populations may have vacated the region amid the onset of an intense glacial episode between 74 and 62 kya, during which time the area may have become hostile for modern humans. Neanderthals are believed to have occupied the region during this time. It remains unclear as to what may have happened to the Qafzeh and Skhul populations. Among the possibilities are that; they died out, moved back to Africa or trekked south into Arabia, serving as source populations for later expansions to Asia.

8.4. Out of Africa III (80 - 60 kya, *Homo sapiens*), Figure 5C

This final dispersal event is thought to be responsible for the successful colonization of Eurasia and Australia by modern humans after 70 kya. The first assumption associated with this dispersal event is that, although archaic humans had occupied Europe and parts of Asia since ~1.8 Mya, these archaic forms were replaced by modern humans who came out of Africa later. The second assumption is that when northward movement from east Africa into southwest Asia was blocked due to the severe conditions in the Sahara Desert with the onset of a glacial episode between 74 and 62 kya, some East African populations launched an eastward dispersal into the Arabian Peninsula through the SR (southern Red Sea); from there they expanded eastward to south and east Asia up to Australia, and northward into the eastern Mediterranean, replacing preexisting archaic humans. The eastward dispersal into India and southeast Asia is understood as a “rapid dispersal,” associated with coastal and estuarine adaptations along the circum-Indian Ocean (Kingdon, 1993; Mellars, 2006b; Bulbeck, 2007).

The main support for this event comes from mtDNA analyses of some aboriginal groups in south Asia, New Guinea and Australia (Forster, 2004; Macaulay et al., 2005; Oppenheimer, 2009). A research team led by Vincent Macaulay of the University Glasgow has identified two mtDNA types called M21 and M22 in native Malaysian populations. These lineages are believed to be descendants of an ancestral L3 haplogroup (Figure 5C), which first appeared as a founder lineage in Africa ~85 kya (Forster and Matsumura, 2005; Macaulay et al., 2005). The short time gap between the coalescence date of L3 (~85 kya) and the arrival of its descendants in South Asia shortly afterwards (~60 kya) suggested to researchers that the initial colonization of south and east Asia involved rapid coastal dispersal of some populations that departed from northeast Africa around 70 kya. According to Oppenheimer (2009) and Macualay et al. (2005) the initial exodus into Arabia is estimated within the range of 85 - 70 kya, resulting in the initial colonization of Australia around 60 kya, with a dispersal rate of 0.7 km/year.

The occupation of Australia by early modern humans sometime between 60 and 50 kya stands out as one of mankind’s incredible feats. Australia was separated from the Asian landmass by a vast body of water during this time; how then did the early inhabitants make it to this island landmass? The accepted (and most plausible) theory is that early humans used floating rafts to reach Australia and its adjacent islands (Van Andel, 1989). Once they set foot on the northern peripheries of Australia, those early inhabitants first travelled along its western coastal margins all the way to the southern tip before venturing into the interior region (Mulvaney and Kamminga, 1999). A similar pattern of dispersal is proposed for early human colonization of the Americas after 20 kya, whereby the first inhabitants of the region (Paleoindians) followed a coastal route to South America along the Pacific rim before moving into the interior territories (Dixon, 2001).

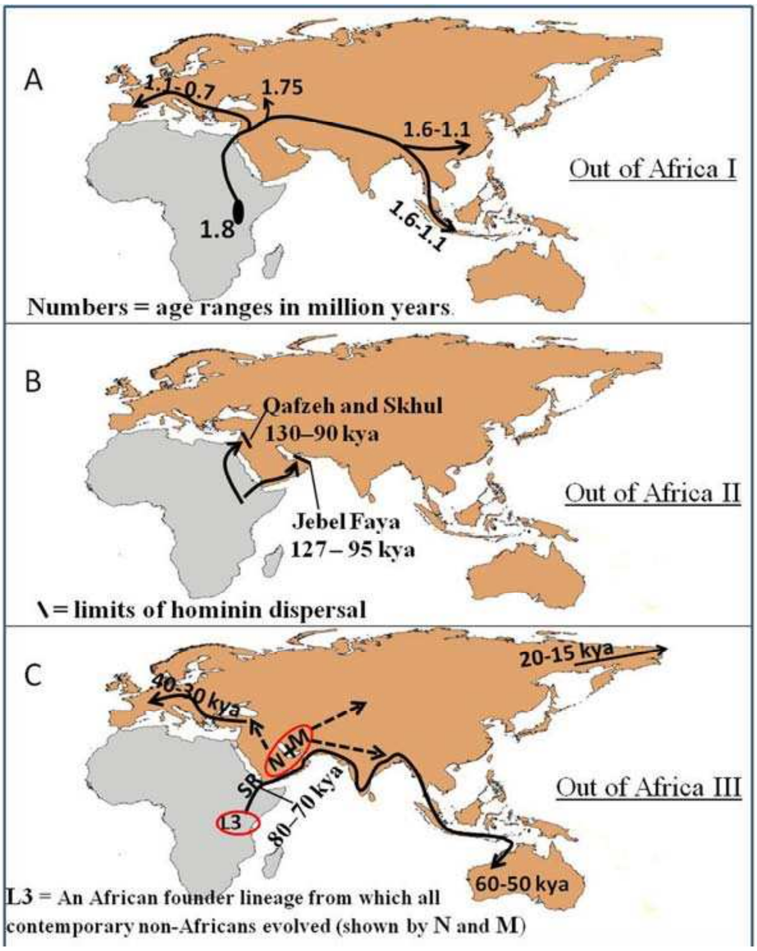


Figure 5. Maps showing age ranges and geographic contexts of early human dispersal episodes out of Africa: A) Out of Africa I (1.9 - 1.0 Mya, *Homo erectus*, dispersal pathways redrawn from Klein 2009, Figure 5.37), B) Out of Africa II (130 - 100 kya, *Homo sapiens*), also known as a temporary dispersal to southwest Asia and Arabia, C) Out of Africa III (80 - 60 kya, *Homo sapiens*). As shown in Map C, the current consensus is that Haplogroup L3 originated as a founder lineage in eastern Africa around 85 kya. Soon after, an East African population carrying L3 migrated into Arabia giving rise to two founder populations known as M and N, from which all contemporary non-Africans originated. The thick bold line indicates the general pathway of the southern dispersal route (SR) along the circum-Indian Ocean (Maps B and C include information from Beyin 2011, Figures 1 and 3 and references therein). Map template source: ESRI © worlddata, drawn by A. Beyin.

One topic that has not received adequate discussion thus far is the timeframe for early human colonization of Europe. The current fossil and archaeological data from Europe suggests that, some members of the genus *Homo* inhabited the region around 1.0 Mya (Klein 2009; table 5.11). This timeframe does not include southwest Asia where several sites dating older than 1.0 Mya have been discovered (ibid., table 5.12). Successful hominin occupation of central and Western Europe must have occurred during interglacials; otherwise much of Europe may have remained uninhabitable during glacial episodes. In this regard, Klein (2009: 368) states, "even after people successfully colonized Europe, continuous occupation appears to have been restricted to the warmer Mediterranean borderlands." The early settlers of Europe and western Asia are thought to have given rise to the Neanderthals, whose evolutionary status remains less well understood.

Regarding early modern human colonization of Europe, Paul Mellars of Cambridge University (2006a) proposes two dispersal phases: i) initial occupation of southeastern Europe around 43 kya from populations that originated in southwest Asia, ii) followed by a westward movement of the southeastern Europeans along the Danube Valley into central, western and southern Europe (Figure 5C). The later dispersal of modern humans into mainland Europe is believed to have involved modern human and Neanderthal contacts. Whether such an encounter led to a peaceful co-existence, confrontation, or interbreeding between the two groups, remains a topic of ongoing investigation.

9. Conclusions and Perspectives

As the reviewed literature demonstrates, understanding the roots of humanity is undoubtedly a most difficult endeavor. At the outset, any attempt to comprehend human evolution requires identifying all the conditions that fostered the evolution of our distinctive biological and cultural qualities. However, given that the course of human evolution has covered a long period of time, our knowledge of the forces that shaped the path to humanity is far from complete. The long list of confounding factors includes the incompleteness of the fossil record and a lack of high resolution environmental data for those regions that hosted hominins at different times. As one can imagine, most fossil remains can decompose or get buried under thick sediments, making it difficult to uncover them. Thus, hindering our knowledge of who is who in the human family tree. Likewise, not all cultural traces may survive to the present, especially if they were made of wood and other perishable materials; thereby limiting our knowledge of the range of cultural innovations by our ancestral hominins. While human evolution cannot be entirely attributed to environmental stimuli, since genetic mutation can independently create new traits, the puzzle of human antiquity and diversity can be better understood when examined in relation to the environmental conditions that prevailed during those critical stages in human evolution.

Glancing at the entire spectrum of human evolution over the past 6 million years, we find a considerable link between the world's climatic patterns and some important milestones in human evolution. For example, bipedalism, which is regarded as the initial step that kindled the path to humanity, emerged in its primitive form around a time when the global climate grew colder and drier leading to the expansion of grasslands. Under such conditions, bipedal posture was found to be most beneficial, and in subsequent periods it fostered the evolution of other important characteristics that enhanced the survival of hominins under variable and unstable conditions. Some of those resulting novel traits included tool-making, expansion of the brain, social bonding, symbolic thought, and plant and animal domestication, each appearing in response to peculiar environmental pressures. Overall, there is an emerging consensus among scholars that the onset of variable global climate throughout the last 6 million years, particularly the repeated glacial and interglacial cycles in the last 2.5 Mya, drove the evolution of the biological and behavioral traits that define the human lineage.

Africa matters considerably in writing narratives of human antiquity. The continent has the longest history of human occupation as attested by the discovery of successive fossil hominins covering the entire span since the separation of our lineage from the chimpanzee line about 6 Mya. The discovery of chronologically, ecologically and taxonomically interrelated hominins along the African rift valley has suggested to scholars that our lineage may have first emerged in the tropical landscapes of eastern Africa. According to King and Bailey (2006) , the path to humanity started when our ancestral hominin was isolated along the drier and varied terrains of the rift valley, where it would have been easy to ambush potential prey around river banks and lakeshores, while making it possible for hominins to evade predators in the rough terrain (cliffs and trees used as shelters). The rift valley, with its north-south orientation, may have also served as a potential dispersal corridor for hominins and mammals from the interior landscapes of eastern Africa northward up to the Red Sea basin and adjacent regions.

While Africa bears a remarkable legacy as the birthplace of humanity, early hominins did not remain confined to Africa, at least in the last 1.8 million years. There is archaeological and fossil evidence that demonstrates that members of the genus *Homo* occupied parts of Eurasia starting around 1.8 Mya and Europe after 1.0 Mya. While the descendants of these migrants certainly survived in these regions for a considerable span of time, most scholars maintain the hypothesis that all contemporary non-African humans descended from people who migrated out of Africa after 100 kya. In view of this premise, descendants of the early settlers of Eurasia remained reproductively isolated from each other, and eventually faced extinction.

As with our past, the fate of humanity will likely hinge on future climate patterns. Thus, humans should not just be concerned about where they stand now, but also where our species will stand in the distant future. As the sole foundation of life-supporting systems, the natural environment continues to shape our place in nature, and the manner in which we interact with each other as groups and as individuals. The kinds of food we consume (organic vs processed), the amount of pollution we put into the environment, the way we are dealing with growing populations, rising environmental crises and communicable diseases, are sure to affect how our species will appear or behave in the future. With the global warming emerging as a major issue-of-concern nowadays, there are compelling reasons to reflect on human antiquity, how past climatic changes have shaped the path to humanity, and how humans can secure their place in nature amid future environmental changes.

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Glossary

Autocatalytic	**:** A concept that denotes a self-initiated process. For example, in the context of hominin dispersals, the discovery of a new attractive habitat may fuel consecutive dispersals into other areas without any external cause.
DNA	**:** An abbreviation for Deoxyribonucleic Acid, which is the genetic pin code of all living things.
Estuaries	**:** Areas where freshwater streams and salty waters meet, usually along coastlines.
Haplotype/haplogroup	**:** a cluster of DNA (genetic makeup) within an organism that is often inherited from a single parent.
Heinrich events	**:** Are short cold periods that occur when the melting of large ice sheets in the North Atlantic releases large amounts of freshwater into the Atlantic Ocean. These freshwater dumps reduced ocean salinity enough to slow heat circulation toward the North Atlantic region (http://www.ncdc.noaa.gov/paleo/abrupt/data3.html).
Hominin	**:** A term that refers to *Homo sapiens* (modern humans) and all extinct fossils of human ancestors who evolved in the past 6 Mya, following the separation of the human line from the chimpanzee line. One trait that all hominins share in common is walking on two legs.
Ibid.	**:** A shortenhand expression for a Latin word "ibidem", which means "in the same place" or "as the last citation".
Isotope	**:** Different versions of a particular chemical element characterized by the same number of protons and electrons but different number of neutrons in the atom.
kya	**:** Thousand years ago.
Last glacial cycle	**:** An episode of repeated glacial cycles covering the time range between 110 kya and 12 kya.
Mya	**:** Million years ago.
Natural Selection	**:** The process by which species with favorable traits survive better and continue to reproduce at a higher rate than those with unfavorable traits.
Paleoenvironment	**:** The study of ancient environments.

Paleoclimate **:** The study of ancient climate patterns.

Palynology **:** The study of ancient pollen remains to glean information about the nature of past vegetation cover and precipitation in a given area.

Refugia **:** An area that offers species a safe haven while the rest of the environment becomes uninhabitable.

Wadi **:** An Arabic term for a riverbed or a watercourse that mostly remains dry except during rainy seasons.

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