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12. Modern *Homo sapiens*

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Learning Objectives

- Identify the skeletal and behavioral traits that represent modern *Homo sapiens.*
- Critically evaluate different types of evidence for the origin of our species in Africa, and our expansion around the world.
- Understand how the human lifestyle changed when people transitioned from foraging to agriculture.

Figure 12.1 The excavation of an exposed cave at Jebel Irhoud, Morocco, where hominin fossils were found in the 1960s and in 2007. Dating showed that they represent the earliest-known modern Homo sapiens.

The walls of a pink limestone cave exposed to the outside world in the hillside of Jebel Irhoud jutted out of the otherwise barren landscape of the Moroccan desert (Figure 12.1). The year was 2007 and it turned out to be a momentous occasion for science. A fossil unearthed by a team of researchers was barely visible to the untrained eye. Just the fossil cranium's robust brows were peering out of the rock. The find was welcome but not sheer luck: Hominin fossils have been found here since their first accidental discovery by miners in 1960. This research team from the Max Planck Institute for Evolutionary Anthropology was just the latest to explore the prehistoric human presence in this part of North Africa. Excavating near the first discovery, the researchers wanted to learn more about how *Homo sapiens* lived far from East Africa, where we thought our species originated.

The scientists were surprised when they analyzed the cranium, named Irhoud 10, and other fossils. Statistical comparisons with other human crania concluded that the Irhoud face shapes were typical of recent modern humans while the braincases matched ancient modern humans. Based on the findings of other scientists, the team expected these modern *Homo sapiens* fossils to be around 200,000 years old. Instead, dating revealed that the cranium had been buried for around 315,000 years.

Together, the modern-looking facial dimensions and the older date changed the interpretation of our species, modern *Homo sapiens*. Our key evolutionary changes from the archaic *Homo sapiens* of the previous chapter to our species today happened 100,000 years earlier than what we had thought. In addition, the new information suggests that our home region covered more of the vast African continent instead of being concentrated in the east.

This big addition to the study of modern *Homo sapiens* is just one of the latest in this continually advancing area of biological anthropology. Researchers are continually discovering amazing fossils and ingenious ways to collect data and test hypotheses about our past. Through the collective work of scientists, including archaeologists, geneticists, and anatomists, we are building an overall theory or explanation of modern human origins. We will first cover the skeletal changes from archaic *Homo sapiens* to modern *Homo sapiens*. Next, we will track how modern *Homo sapiens* expanded the range of its species around the world. Lastly, we will cover the development of agriculture and how it changed human culture to how we practice it today.

DEFINING MODERNITY

What defines a modern *Homo sapiens* when compared to an archaic *Homo sapiens*, like the ones in the previous chapter? Modern humans, like you and me, have a set of derived traits that are not seen in archaic humans or any other hominin. As with other transitions in hominin evolution, such as increasing brain size and bipedal ability, modern traits do not appear fully formed or all at once. In other words, the first modern *Homo sapiens* was not just born one day from archaic parents. The traits common to modern *Homo sapiens* appeared in a **mosaic** manner: gradually and out of sync with one another. There are two areas to consider when tracking the complex evolution of modern human traits. One is the physical change in the skeleton. The other is behavior inferred from the cranium and material culture.

Skeletal Traits

The skeleton of a modern *Homo sapiens* is less robust than that of an archaic *Homo sapiens*. In other words, the modern skeleton is **gracile**, meaning that the structures are thinner and smoother. Differences related to gracility in the cranium are seen in the braincase, the face, and the mandible. There are also broad differences in the rest of the skeleton.

Cranial Traits

Several elements of the braincase differ between modern and archaic *Homo sapiens*. Overall, the shape is much rounder, or more **globular**, on a modern skull (Lieberman, McBratney, and Krovitz 2002; Neubauer, Hublin, and Gunz 2018; Pearson 2008) (Figure 12.2). You can feel the globularity of the modern human skull on the example built into you. Feel the height of your forehead with the palm of your hand. Viewed from the side, the tall vertical forehead of a modern *Homo sapiens* stands out when compared to the sloping archaic version. This is because the frontal lobe of the modern human brain is larger than the one in archaic humans, and the skull has to accommodate the expansion. The vertical forehead reduces a trait that is common to all other hominins: the brow ridge or **supraorbital torus**. The sides of the braincase also exhibit changes associated with the globular expansion of the brain: the parietal lobes of the brain and the matching parietal bones of the skull both bulge outward more in modern humans. At the back of the skull, the archaic occipital bun is no longer present. Instead, the occipital region of the modern human cranium has a derived tall and smooth curve, again reflecting the globular brain inside. The different priorities in brain regions may also indicate cognitive and behavioral differences between archaic humans and modern humans, discussed in the next section.

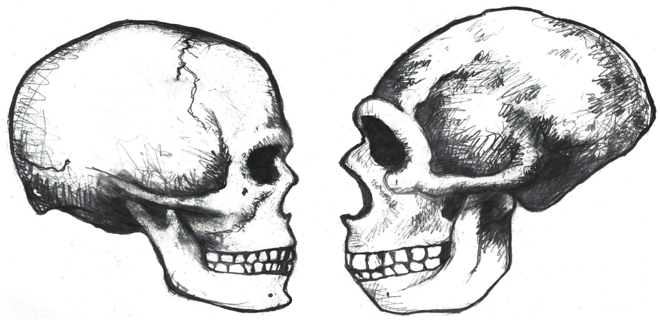


Figure 12.2 Comparison between modern (left) and archaic (right) Homo sapiens skulls. Note the overall gracility of the modern skull, as well as the globular braincase.

The trend of shrinking face size across hominins reaches its extreme with our species as well. The facial bones of a modern *Homo sapiens* are extremely gracile compared to all other hominins (Lieberman, McBratney, and Krovitz 2002). One specific dimension to compare is the thickness of the zygomatic arches, or cheekbones. As with the shrinking of the face leading up to our species, the decreasing reliance on needing large teeth for survival may have been the reason that modern human faces are so gracile in comparison to other humans. Continuing a trend in hominin evolution, technological innovations kept reducing the importance of teeth in reproductive success (Lucas 2007). As natural selection favored smaller and smaller teeth, the surrounding bone holding these teeth also shrank.

Connected to the face, the mandible is also gracile in modern humans when compared to archaic humans and other hominins. Interestingly, our mandibles have pulled back so far from the prognathism of earlier hominins that we gained an extra structure at the most anterior point, called the **mental eminence**. You know this structure as the chin: trace your own chin and feel how it curves forward before swooping posteriorly toward your neck. At the skeletal level, it resembles an upside-down "T" at the centerline of the mandible (Pearson 2008). If you look back at illustrations of other hominins, you will see that they all lack a chin. Instead, their mandibles curve straight back without a forward point. What is the chin for and how did it develop? Flora Gröning and colleagues (2011) found evidence of the chin's importance by simulating physical forces on computer models of different mandible shapes. Their results showed that the chin acts as structural support to withstand strain on the otherwise gracile mandible. In other words, as natural selection favored smaller dentition, the chin developed to maintain structural integrity of the mandible.

Post-Cranial Gracility

The rest of the modern human skeleton is also more gracile than its archaic counterpart. The differences are clear when comparing a modern *Homo sapiens* with a cold-adapted Neanderthal (Sawyer and Maley 2005), but the trends are still present when comparing modern and archaic humans within Africa (Pearson 2000). Overall, a modern *Homo sapiens* post-cranial skeleton has thinner cortical bone, smoother features, and more slender shapes when compared to archaic *Homo sapiens* (Figure 12.3). For example, the modern pelvis has gracile features along its surface and is narrower in overall width. Our elbow and knee joint surfaces are also narrower. Even the individual fingers and toes are more slender in modern humans. Comparing whole skeletons, modern humans have longer limb proportions relative to the length and width of the torso, giving us lankier outlines.

As with the cranial traits, we have to consider the evolutionary process behind postcranial gracility. Why is our skeleton so gracile compared to those of other hominins? Natural selection can drive the gracilization of skeletons in several ways (Lieberman 2015). A slender frame is adapted for the efficient long-distance running ability that started with *Homo erectus*. Furthermore, slenderness is a genetic adaptation for cooling an active body in hotter climates, which aligns with the ample evidence that Africa was the home continent of our species.

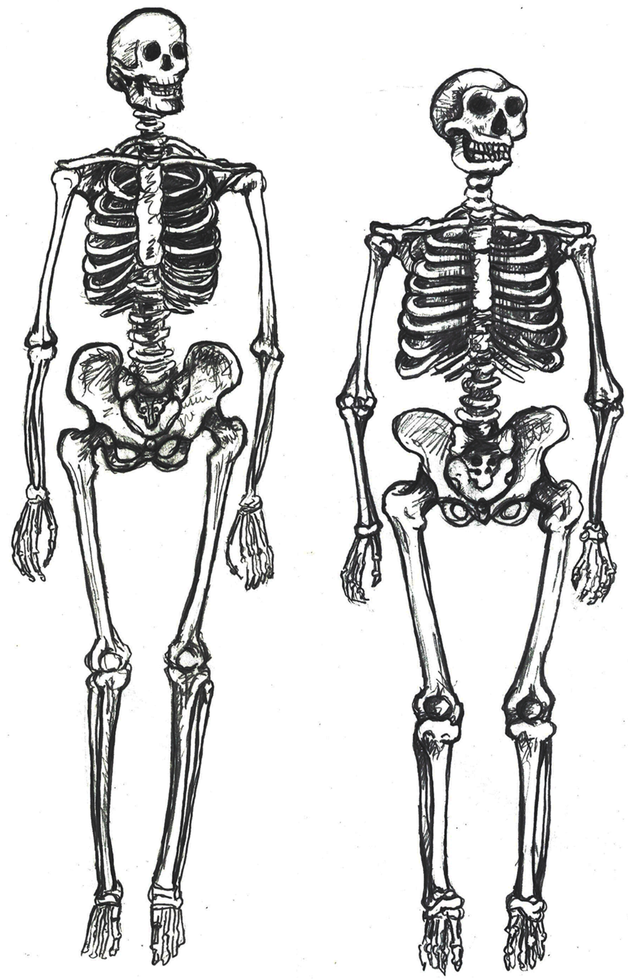


Figure 12.3 Anterior views of modern (left) and archaic (right) Homo sapiens skeletons. The modern human has an overall gracile appearance at this scale as well.

Behavioral Modernity

Aside from physical differences in the skeleton, researchers have also tracked clues of behavioral changes from archaic to modern humans. From the anthropology of our species today, we know that we practice a very complex version of culture, with many layers to our language, art, social organization, and technology, among other areas. Did cultural complexity increase gradually or quickly with the first modern humans? This question is being actively investigated. A major obstacle to answering this question is that it is hard to define and measure cultural complexity. Since we cannot directly observe humans of the distant past, we have to infer these measures of human behavior from other types of evidence. Two particularly illuminating areas are archaeology and the analysis of reconstructed brains.

Archaeology tells us much about the behavioral complexity of past humans by interpreting the significance of material culture. In terms of evolved advanced culture, items created with an artistic flair, or as a decorative piece, speak of some abstract thought process (Figure 12.4). The demonstration of difficult artistic techniques and technological skills hints at social learning and cooperation as well. For example, most of your skills were taught to you by a more experienced person, upon which you've developed your own style with practice. Some day you may pass on what you know to someone else using language to convey your knowledge. The same process is believed to have happened with early modern humans in areas such as toolmaking and craftwork, producing the sophisticated material culture that we can now study. According to paleoanthropologist John Shea (2011), one way to track the complexity of past behavior through artifacts is by measuring the variety of tools found together. The more types of tools constructed with different techniques and for different purposes, the more modern the behavior. Turning this view to ourselves, think of all of the tools we have available to us today at a typical hardware store and the cumulative knowledge they represent. This idea of measuring past behavior is promising, but researchers are still working on an archaeological way to measure cultural complexity that is useful across time and place.

Figure 12.4 Carved ivory figure called the Lion-Man of the Hohlenstein-Stadel. It dates to the Aurignacian culture, between 35 and 40 kya. What does this artifact suggest about the culture and technical skill of its artist?

The interpretation of brain anatomy is another promising approach to studying the evolution of human behavior. When looking at the body of work on this topic in modern *Homo sapiens* brains, researchers found a weak association between brain size and test-measured intelligence (Pietschnig et al. 2015). This means that there are more significant factors that affect tested intelligence than just brain size. Additionally, they found no association between intelligence and biological sex. Since the sheer size of the brain is not useful for weighing intelligence, paleoanthropologists are instead investigating the differences in certain brain structures. The differences in organization between modern *Homo sapiens* brains and archaic *Homo sapiens* brains may reflect different cognitive priorities that account for modern human culture. Researchers (e.g., Bruner 2010) have hypothesized that the expanded frontal and parietal lobes in the globular modern human braincases mean that we can do more complex thinking regarding memory and social ability than the Neanderthals could. In contrast, the Neanderthal brain prioritized the visual regions where the occipital bun was located, with fewer neurons in the frontal area for complex thinking. As with the archaeological line of research in the preceding paragraph, this is a very active area of investigation. New discoveries will refine what we know about the human brain and apply that knowledge to studying the distant past.

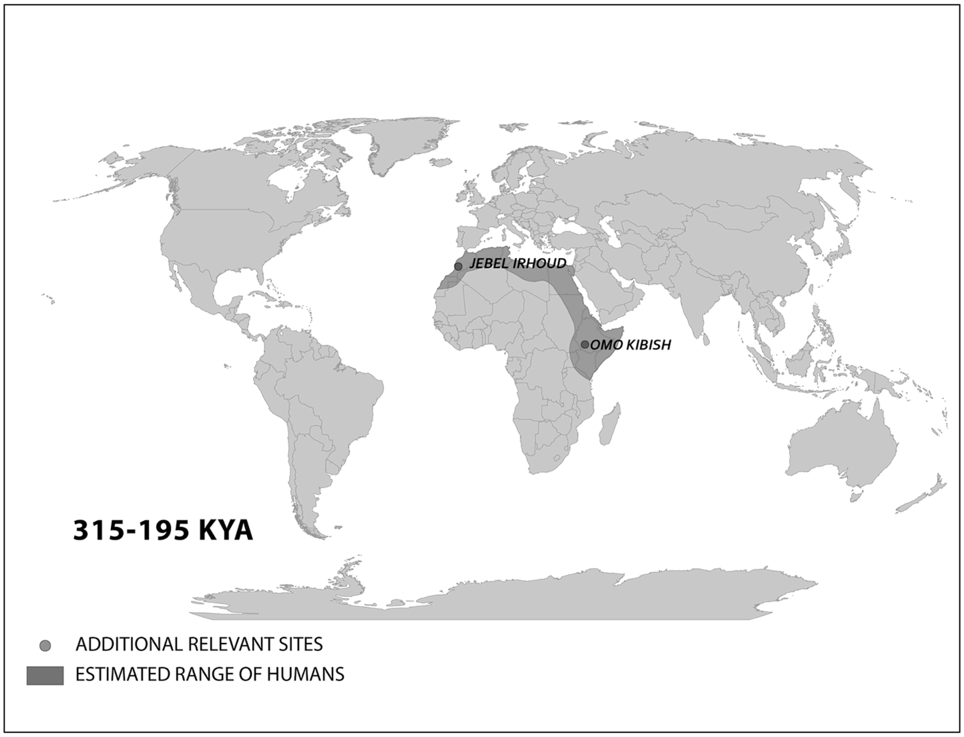
Taken together, the cognitive abilities in modern humans may have translated into an adept use of tools to enhance survival. The ability to process a new environment, adapt to it with innovative technology, and pass on that knowledge may be the key behind the success of modern *Homo sapiens*. Researchers Patrick Roberts and Brian A. Stewart call this concept the **generalist-specialist niche**: Our species is an expert at living in a wide array of environments, with populations culturally specializing in their own particular surroundings (Roberts and Stewart 2018). The next section tracks how far around the world these skeletal and behavioral traits have taken us.

FIRST AFRICA, THEN THE WORLD

What enabled modern *Homo sapiens* to expand its range further in 300,000 years than *Homo erectus* did in 1.5 million years? The key is the set of derived biological traits from the last section. The gracile frame and neurological anatomy allowed modern humans to survive and even flourish in the vastly different environments they encountered. Based on multiple types of evidence, the source of all of these modern humans, including all of us today, was Africa.

This section traces the origin of modern *Homo sapiens* and the massive expansion of our species across all of the continents except Antarctica by 12,000 years ago. While modern *Homo sapiens* first shared geography with archaic humans, modern humans eventually spread into lands where no human had gone before. Starting with the first-known modern *Homo sapiens*, around 315,000 years ago, we will follow our species from a time called the Middle Pleistocene to the end of the Late Pleistocene. Culturally, we will trace developments from the **Middle Stone Age** through the transition around 50,000 years ago to the **Later Stone Age**, when cultural complexity quickly grew with both technology and artistry. We will end this section right before the next big cultural change, called the Neolithic Revolution.

A few notes on this part of the chapter: It is organized from past to present when possible, though a lot happens simultaneously to our species in that time. Figure 12.5 shows the broad routes that our species took expanding around the world. I encourage you to make your own timeline with the dates in this part to see the overall trends. References are provided to the research leading to the information on key finds. Search for these scientific papers online to see how researchers reach the conclusions presented here.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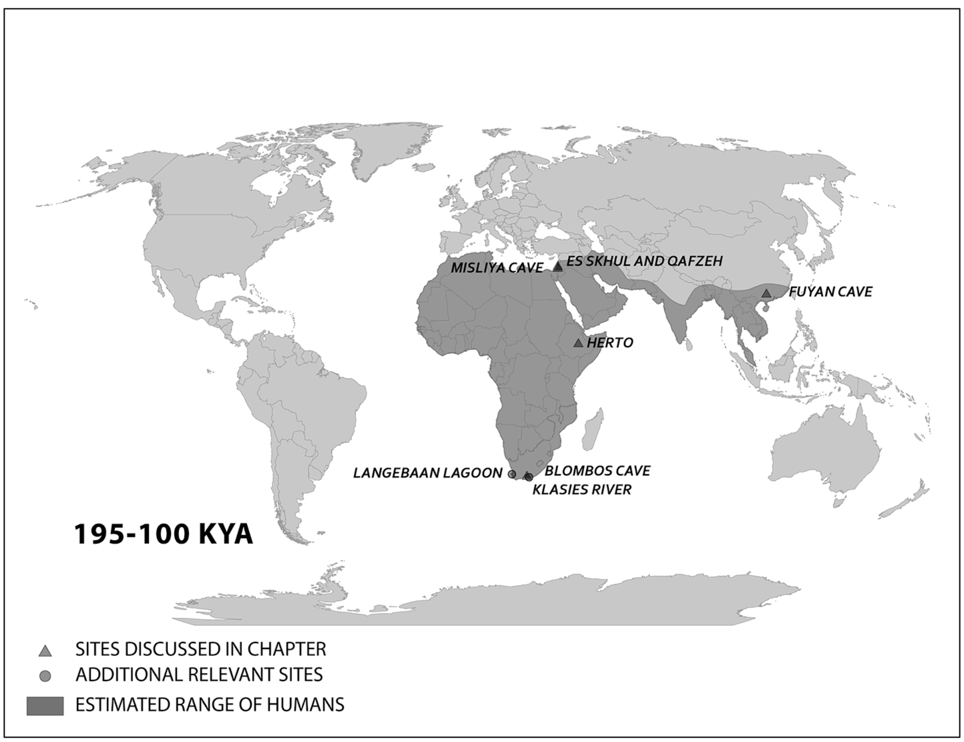
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FUYAN CAVE
HERTO
LANGEBAAN LAGOON
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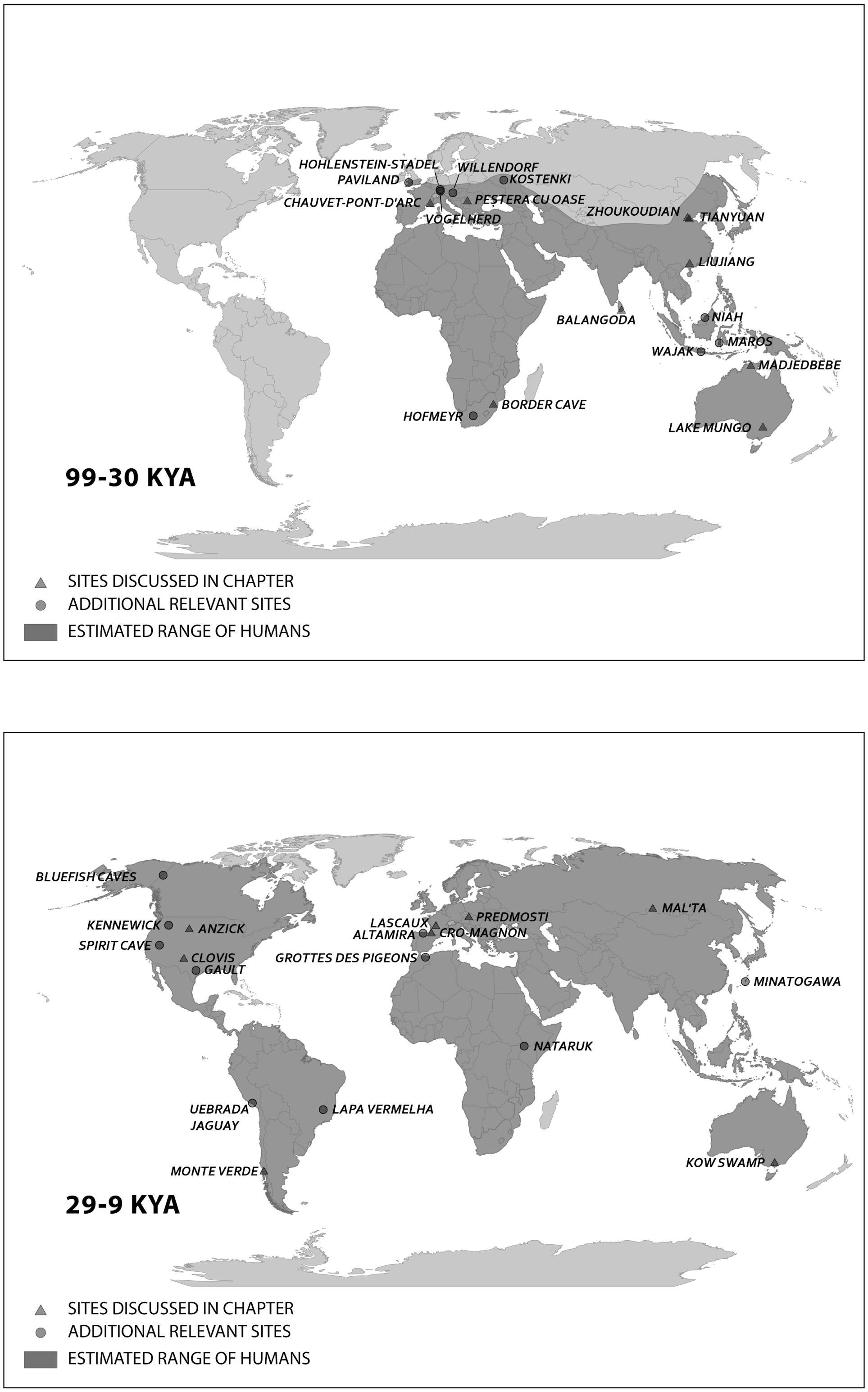

Figure 12.5 Maps depicting the estimated range of modern Homo sapiens through time. The shaded area is based on geographical connections across known sites. Note the growth in area starting in Africa and the oftentimes coastal routes that populations followed.

The Start of Modern *Homo sapiens* in Africa

We start with the ample fossil evidence supporting the theory that modern humans originated in Africa during the Middle Pleistocene, having evolved from African archaic *Homo sapiens*. The earliest dated fossils considered to be modern actually have a mosaic of archaic and modern traits, showing the complex changes from one type to the other. Experts have various names for these transitional fossils, such as **Early Modern *Homo sapiens*** or **Early Anatomically Modern Humans**. However they are labeled, the presence of some modern traits means that they illustrate the origin of the modern type. Three particularly informative sites with fossils of the earliest modern *Homo sapiens* are Jebel Irhoud, Omo, and Herto.

Recall from the start of the chapter that the most recent finds at Jebel Irhoud are now the oldest dated fossils that exhibit the traits of modern *Homo sapiens*. Besides Irhoud 10, the cranium that was dated to 315,000 years ago (Hublin et al. 2017; Richter et al. 2017), there were other fossils found in the same deposit that we now know are from the same time period. In total there are at least five individuals, representing life stages from childhood to adulthood. These fossils form an image of high variation in skeletal traits. For example, the skull named Irhoud 1 has a primitive brow ridge, while Irhoud 2 and Irhoud 10 do not (Figure 12.6). The braincases are lower than what is seen in the modern humans of today but higher than in archaic *Homo sapiens*. The teeth also have a mix of archaic and modern traits that defy clear categorization into either group.

Research separated by nearly four decades uncovered fossils and artifacts from the Kibish Formation in the Lower Omo Valley in Ethiopia. These Omo Kibish hominins were represented by braincases and fragmented postcranial bones of three individuals found kilometers apart, dating back to 195,000 years ago (Day 1969; McDougall, Brown, and Fleagle 2005). One interesting finding was the variation in braincase size between the two more-complete specimens: While the individual now named Omo I had a more globular dome, Omo II had an archaic-style long and low cranium. In more recent fieldwork, an informative section of the Omo I pelvis was found in a re-excavation in 2001. Analysis by Ashley S. Hammond and colleagues (2017) found that the measurements and observations were in line with modern *Homo sapiens*, although larger in absolute size and robusticity.

Figure 12.6 Composite rendering of the Jebel Irhoud hominin based on micro-CT scans of multiple fossils from the site. The facial structure is within the modern human range, while the braincase is between the archaic and modern shapes.

Also in Ethiopia, a team led by Tim White (2003) excavated numerous fossils at Herto. There were fossilized crania of two adults and a child, along with fragments of more individuals. The dates ranged between 160,000 and 154,000 years ago. The skeletal traits and stone tool assemblage were both intermediate between the archaic and modern types. Features reminiscent of modern humans included a tall braincase and thinner zygomatic (cheek) bones than those of archaic humans (Figure 12.7). Still, some archaic traits persisted in the Herto fossils. Looking at the face, the supraorbital tori were still prominent. The cranium included an angled occipital bone and was longer than in present-day modern *Homo sapiens*. Statistical analysis by other research teams concluded that at least some cranial measurements fit just within the modern human range (McCarthy and Lucas 2014), favoring categorization with our own species.

Figure 12.7 This model of the Herto cranium showing its mosaic of archaic and modern traits.

Summary of Early Modern H. sapiens *in Africa*

The combined fossil evidence paints a picture of diversity in geography and traits. Instead of evolving in just East Africa, the Jebel Irhoud find revealed that early modern *Homo sapiens* had a wide range across Middle Pleistocene Africa. The hypothesis that there was no single original home within Africa for our species is called **African multiregionalism** (Scerri et al. 2018). Supporting this explanation, fossils have different mosaics of archaic and modern traits in different places and even within the same area. The high level of diversity from just these fossils shows that the modern traits took separate paths toward the set we have today. The connections were convoluted, involving fluctuating gene flow among small groups of regional nomadic foragers across a large continent over a long time.

What about behavioral modernity? Jebel Irhoud, Omo, and Herto all bore Middle Stone Age tools of the same flaked style as archaic assemblages, even though they were separated by almost 150,000 years. The apparent stability in technology may be evidence that behavioral modernity was not so developed back then, though there was a high variety of tool types used throughout that time. No clear signs of art dating back this far have been found either. Other hypotheses not related to behavioral modernity could explain these observations. The tool set may have been suitable for thriving in Africa without further innovation. As for the lack of art, maybe works from that time were made with media that deteriorated or perhaps such works were removed by later humans.

While modern *Homo sapiens* lived across Africa, some members eventually left the continent. Generations of these pioneers entered environments far different from what their ancestors experienced in Africa. The next four sections cover evidence of modern *Homo sapiens* in other parts of the Old World and the evidence we have about what they did. We will check back with Africa later in the chapter to see what happened biologically and culturally on the home front amid the expansion.

Expansion into the Middle East and Asia

This section presents key finds showing where modern *Homo sapiens* went after the range of the species first extended out of Africa. These pioneers could have used two connections to the Middle East, or West Asia. From North Africa, they could have crossed the Sinai Peninsula and moved north to the **Levant**, or eastern Mediterranean. Finds in that region show an early modern human presence. Other finds support the **Southern Dispersal model**, with a crossing from East Africa to the southern Arabian Peninsula through the Straits of Bab-el-Mandeb. It is tempting to think of one momentous event in which people stepped off Africa and into the Middle East, never to look back. In reality, there were likely multiple waves of movement producing gene flow back and forth across these regions. The expanding modern human population could have thrived by using resources along the southern coast of the Arabian Peninsula to South Asia, with side routes moving north along rivers. The maximum range of the species then grew across Asia as shown by evidence across the continent.

Modern Homo sapiens *in the Middle East*

Geographically, the Middle East is the ideal place for the African modern *Homo sapiens* population to inhabit upon expanding out of their home continent. In the Eastern Mediterranean coast of the Levant, there is a wealth of skeletal and material culture linked to modern *Homo sapiens*. Recent discoveries from Saudi Arabia further add to our view of human life just beyond Africa.

The Caves of Mount Carmel in present-day Israel have preserved skeletal remains and artifacts of modern *Homo sapiens*, the first-known group living outside Africa. The skeletal presence at Misliya Cave is represented by just part of the left upper jaw of one individual, but it is notable for being dated to a very early time, between 194,000 and 177,000 years ago (Hershkovitz et al. 2018). Later, from 120,000 to 90,000 years ago, fossils of multiple individuals across life stages were found in the caves of Es-Skhul and Qafzeh (Shea and Bar-Yosef 2005). The skeletons had many modern *Homo sapiens* traits, such as globular crania and more gracile postcranial bones when compared to Neanderthals. Still, there were some archaic traits. For example, the adult male Skhul V also possessed what researchers Daniel Lieberman, Osbjorn Pearson, and Kenneth Mowbray (2000) called marked or clear occipital bunning. Also, compared to later modern humans, the Mount Carmel people were more robust. Skhul V had a particularly impressive brow ridge that was short in height but sharply jutted forward above the eyes (Figure 12.8). The high level of preservation is due to the intentional burial of some of these people. Besides skeletal material, there are signs of artistic or symbolic behavior. For example, the adult male Skhul V had a boar's jaw on his chest. Similarly, Qafzeh 11, a juvenile with healed cranial trauma, had an impressive deer antler rack placed over his torso (Figure 12.9) (Coqueugniot et al. 2014). Perforated seashells colored with **ochre**, mineral-based pigment, were also found in Qafzeh (Bar-Yosef Mayer, Vandermeersch, and Bar-Yosef 2009).

Figure 12.8 This Skhul V cranium model shows the sharp browridges. The contour of a marked occipital bun is barely visible from this angle.

Figure 12.9 This cast of the Qafzeh 11 burial shows the antler's placement over the upper torso. The forearm bones appear to overlap the antler.

One remaining question is, what happened to the modern humans of the Levant after 90,000 years ago? Another site attributed to our species did not appear in the region until 47,000 years ago. Competition with Neanderthals may have accounted for the disappearance of modern human occupation since the Neanderthal presence in the Levant lasted longer than the dates of the early modern *Homo sapiens*. John Shea and Ofer Bar-Yosef (2005) hypothesized that the Mount Carmel modern humans were an initial expansion from Africa but one that failed. Perhaps they could not succeed due to competition with the Neanderthals who had been there longer and had both cultural and biological adaptations to that environment.

Six-hundred kilometers from Mount Carmel, the fossil AW-1 from Al Wusta in Saudi Arabia was just one finger bone, but it greatly enhanced our view of modern *Homo sapiens* just outside Africa. Dating methods converged on a range between 130,000 and 90,000 years ago, overlapping the Skhul and Qafzeh range (Groucutt et al. 2018). The AW-1 bone and its associated stone tools added to evidence of many sites dotted throughout the Arabian Peninsula that contained stone tools but not skeletal remains.

Modern Homo sapiens *of China*

A long history of paleoanthropology in China has found ample evidence of modern human presence. Four notable sites are the caves at Fuyan, Liujiang, Tianyuan, and Zhoukoudian. In the distant past, these caves would have been at least seasonal shelters that unintentionally preserved evidence of human presence for modern researchers to discover.

At Fuyan Cave in Southern China, paleoanthropologists found 47 adult teeth associated with cave formations dated to between 120,000 and 80,000 years ago (Liu et al. 2015). It is currently the oldest-known modern human site in China, though other researchers question the validity of the date range (Michel et al. 2016). The teeth have the small size and gracile features of modern *Homo sapiens* dentition. No lithics have been found in Fuyan Cave.

Figure 12.10 The Liujiang cranium shows the tall forehead and overall gracile appearance typical of modern Homo sapiens.

The fossil Liujiang (or Liukiang) hominin has derived traits that classified it as a modern *Homo sapiens*, though primitive archaic traits were also present. In the skull, which was found nearly complete, the Liujiang hominin had a taller forehead than archaic *Homo sapiens* but also had an enlarged occipital region (Figure 12.10) (Brown 1999). A reconstruction of the brain based on the endocast of the cranium confirmed these trends along with a larger overall volume (Wu et al. 2008). Other parts of the skeleton also had a mix of modern and archaic traits: for example, the femur fragments suggested a slender length but with thick bone walls (Woo 1959). Dating methods suggested an age of around 67,000 years.

A mandible fragment, teeth, and postcranial skeletal remains of a single adult of indeterminate sex was found by tree farmers in Tianyuan, 50 km from Beijing (Tong 2004). Radiocarbon dating of the bones estimated that they were from 42,000 to 39,000 years ago (Shang et al. 2007). As with other fossils described in this section, researchers noted a few transitional traits between archaic and modern categories, such as deep tooth measurements (the anteroposterior or front-to-back dimension) and a robust tibia. The Tianyuan fossils also had some antemortem tooth loss (which happened during life), osteoarthritis of a left-hand finger joint, and enlargements to muscle attachment sites of the tibia and femur. The evidence pointed to a physically demanding life.

The last Chinese site to describe here is the one that has been studied the longest. In the Zhoukoudian Cave system, where *Homo erectus* and archaic *Homo sapiens* have also been found, there were three crania that fit the modern *Homo sapiens* set of traits (Figure 12.11). These crania were in a part of the cave called the Upper Cave, dating to between 34,000 and 10,000 years ago. The crania were all more globular than that of archaic humans but still lower and longer than later modern humans' (Brown 1999; Harvati 2009). When compared to one another, the three Upper Cave crania showed significant differences from one another. Comparison of cranial measurements to other populations past and present found no connection with modern East Asians. These findings again show that human variation was very different from what we see today.

Figure 12.11 The entrance to the Upper Cave of the Zhoukoudian complex, where crania of three prehistoric modern humans were found.

Other Asian Modern Humans

Other discoveries in Asia show us where modern *Homo sapiens* went after the initial expansion. Sites with evidence of modern human occupation stretch from the island of Sri Lanka north to Siberia. The first modern humans may have followed rivers north to settle in colder regions while still accessing the rich freshwater environment.

The Balangoda hominins refer to around 36 modern humans as far back as 38,000 years ago whose fossils were found in numerous cave sites around Sri Lanka (Kennedy et al. 1987). The name also refers to one particularly well-studied skeleton from the archaeological site of Batadombalena. Measurements of Balangoda Man show a closeness to the modern-day Vedda people who live in Sri Lanka, suggesting a direct ancestral relationship. Ornamentation such as pendants and beads, and the presence of shark teeth far from the coast, supported the presence of modern behavior as they were possibly transported for their aesthetic or symbolic value rather than their practical use.

A double-infant burial dated to 28,000 years ago was found in 1928 at the site of Mal'ta in southern Siberia, north of Mongolia (Raghavan et al. 2014). Researchers named the three- to four-year-old individual MA-1. This burial was decorated with Later Stone Age decorations: a beaded necklace, pendants, and a headband. Other accessories and lithics were buried with the pair. Genetic analysis of MA-1 found a connection with both present-day Western Europeans and Native Americans but not East Asians. This finding hints at the complex routes people took in the expansion of the species.

Summary of Modern H. sapiens *in the Middle East and Asia*

As in Africa, the finds of the Middle East have shown that humans were biologically diverse and had complex relationships with their environment. Work in the Levant showed an initial expansion north from the Sinai Peninsula that did not last. Away from the Levant, expansion continued. People were present in Saudi Arabia, too, as rainfall increased the amount of habitable land. Local resources were used to make lithics and decorative items.

The early Asian presence of modern *Homo sapiens* was complex and varied as befitting the massive continent. What the evidence shows is that people adapted to a wide array of environments that were far removed from Africa. From the

Levant to Sri Lanka, Siberia, and China, humans with modern anatomy used caves that preserved signs of their presence. Faunal and floral remains found in these shelters speak to the flexibility of the human omnivorous diet as local wildlife and foliage became nourishment. Decorative items, often found as burial goods in planned graves, show a flourishing cultural life.

Eventually, modern humans at the southeastern fringe of the geographical range of the species found their way southeast until some became the first humans in Australia.

Crossing to Australia

Expansion of the first modern human Asians, still following the coast, eventually entered an area called **Sunda** by researchers before continuing on to modern Australia. Sunda was a landmass made up of the modern-day Malay Peninsula, Sumatra, Java, and Borneo. Lowered sea levels connected these places with land bridges, making them easier to traverse. Proceeding past Sunda meant navigating **Wallacea**, the archipelago that includes the Indonesian islands east of Borneo. The name refers to naturalist Sir Alfred Russel Wallace, who noted that organisms from this region differed from those to the west. Prehistorically, there were many **megafauna**, large animals that migrating humans would have used for food and materials such as hides and bones. Further southeast was another prehistoric landmass called **Sahul**, which included New Guinea and Australia as one contiguous continent. This land had never seen hominins or any other primates before modern *Homo sapiens* arrived. Sites along this path offer clues about how our species handled these changes to the local environment to live successfully as foragers.

While no fossil humans have been found at the Madjedbebe rock shelter in the North Territory of Australia, more than 10,000 artifacts found there show both behavioral modernity and variability (Clarkson et al. 2017). They include a diverse array of stone tools and different shades of ochre for rock art, including mica-based reflective pigment (similar to glitter). The ochre were shaped into what the researchers called “crayons” to be held and used to mark other things. There were also plant and animal remains matching the tools used to process them. One notable find in this category is the partial upper jaw of a thylacine, or Tasmanian wolf, which was colored red. These impressive artifacts date as far back as 56,000 years ago, providing the date for the earliest-known presence of humans in Australia.

The skeletal remains at Lake Mungo are the oldest known in the continent. The lake, now dry, was one of a series located along the southern coast of Australia in New South Wales, far from where the first people entered from the north (Barbetti and Allen 1972; Bowler et al. 1970). Two individuals dating to around 40,000 years ago show signs of artistic and symbolic behavior, including intentional burial. The bones of Lake Mungo 1 (LM1), an adult female, were crushed repeatedly, colored with red ochre, and even cremated (Bowler et al. 1970). Lake Mungo 3 (LM3), a tall older male with a gracile cranium but robust postcranial bones, had his fingers interlocked over his pelvic region (Brown 2000).

Kow Swamp, also in southern Australia, contained human crania that looked distinctly different from the ones at Lake Mungo (Durband 2014; Thorne and Macumber 1972). The Kow Swamp crania had extremely robust brow ridges and thick bone walls, but these were paired with globular features on the braincase (Figure 12.12). The frontal bones had extremely linear slopes from the brow to the top of the cranium, resembling intentional cranial modification seen in other parts of the world. If the crania were shaped on purpose, they are another sign of symbolic behavior, as the practice has linked to ideas of group cultural identity. By the time of the Kow Swamp people, between 9,000 and 20,000 years ago, cranial modification may have been a meaningful part of culture in southern Australia.

Summary of Modern H. sapiens *in Australia*

Figure 12.12 Replica of the Kow Swamp 1 cranium. The shape of the braincase could be due to artificial cranial modification. A competing hypothesis is that it reflects the primitive shape of Homo erectus.

The presence of the first humans in Australia along the current northern and southern coasts suggests that they used a route that wrapped around the perimeter of the continent. This path allowed access to both coastal and inland resources. Megafauna was a likely source of food and other resources. The mythology of Australian aborigines today has been linked by researchers to extinct life, such as marsupial tapirs and lions. Predation by humans may be why the megafauna became extinct, leaving the oral tradition of their existence.

The abundant evidence matching the criteria for behavioral modernity shows that the early Australians had a rich artistic and symbolic life. Raw materials must have been transported or traded across long distances in order to make art and color both human and nonhuman skeletal remains. The local varieties of stone tools and art may reflect cultural variation across distant regions of the continent.

The overall view of the first modern humans in Australia from a biological perspective shows a high amount of skeletal diversity. This is similar to the trends seen earlier in Africa, the Middle East, and East Asia. While the Lake Mungo individuals had derived gracile cranial traits, the Kow Swamp crania were measurably more robust.

Northwest to Europe

The first modern human expansion into Europe occurred after other members of our species settled East Asia and Australia. As the evidence from the Levant suggests, modern human movement to Europe may have been hampered by the presence of Neanderthals. Another obstacle was that the colder climate was incompatible with the biology of African modern *Homo sapiens*, which was adapted for exposure to high heat and ultraviolet radiation. Still, by 40,000 years ago, modern *Homo sapiens* had enough of a presence in Europe to leave evidence for researchers to find. This time was also the start of the Later Stone Age or **Upper Paleolithic**, with an expansion in cultural complexity. Connected with the history of science in general, early modern *Homo sapiens* in Europe have been studied for centuries. Due to the bias in research focus favoring Europe, there is a wealth of evidence to explore. Still, there are also eye-opening discoveries in this area today. This section will cover some of the key evidence of early modern human life in Europe, then go over the typologies used to view the cultural changes in this region.

In Romania, the site of Peștera cu Oase (Cave of Bones) had the oldest known remains of modern *Homo sapiens* in Europe, dated to around 40,000 years ago (Trinkaus et al. 2003a). Among the bones and teeth of cave bears, wolves, ibex, and other animals were the fragmented cranium of one person and the mandible of another (the two bones did not fit each other). Both bones have modern human traits similar to the fossils from the Middle East, but they also had Neanderthal traits. Oase 1, the mandible, has a mental eminence but also extremely large molars (Trinkaus et al. 2003b). This mandible has yielded DNA, opening another dimension of study. Surprisingly, DNA from Oase 1 is equally similar to DNA from present-day Europeans and Asians (Fu et al. 2015). This means that Oase 1 was not the direct ancestor of modern Europeans. The Oase 2 cranium has the derived traits of reduced brow ridges along with archaic wide zygomatic cheekbones (Figure 12.13) (Rougier et al. 2007). What the braincase shows is also between the two extremes: an overall globular shape that had a tall but sloped frontal bone and an occipital bun-like protrusion at the other end. No artifacts were found at this site. The assemblage was likely gathered by either carnivores or geological events such as water action since the Oase human bones were found with a high amount of nonhuman remains.

Figure 12.13 This side view of the Oase 2 cranium shows the reduced brow ridges but also occipital bunning that is a sign that modern Homo sapiens interbred with Neanderthals.

The term “Cro-Magnon” has entered public usage as a name for any prehistoric modern European *Homo sapiens*, and maybe any “caveman” of our species, but it technically refers to four adults (three male and one female) and an infant found in the Cro-Magnon rock shelter in France in 1868 (Balzeau et al. 2013). The remains are dated to 28,000 years ago and may all have been intentionally buried along with over 300 pierced seashells and nonhuman skeletal remains.The Cro-Magnon crania are easily identifiable by their rectangular eye orbits, which are more angular than any contemporary (Figure 12.14). Compared to Neanderthal skeletons of the same region, the Cro-Magnons are extremely gracile. The adults also show signs of much pathology, including fused neck vertebrae and healed fractures. The individual Cro-Magnon 1 has skeletal lesions typical of neurofibromatosis type 1, a rare genetic disease that causes tumor growth (Charlier et al. 2018). The combination of disease markers suggest that life for the Cro-Magnons was so physically demanding that it greatly affected the skeleton.

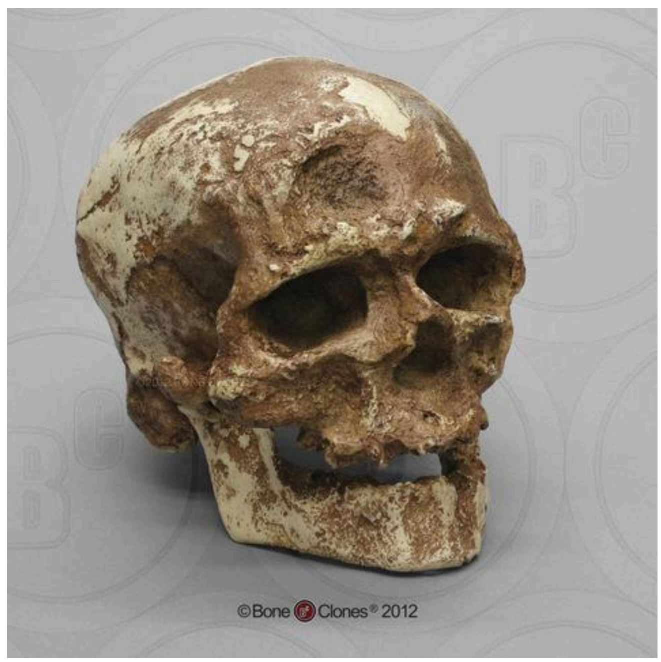

Figure 12.14 This reconstruction of the Cro-Magnon 1 skull shows the gracility of modern Homo sapiens along with a disease that marked the bone.

Dating to around 26,000 years ago, Předmostí near Přerov in the Czech Republic was a site where people buried over 30 individuals along with many artifacts. Eighteen individuals were found in one mass burial area, a few covered by the scapulae of woolly mammoths (Germonpré, Lázničková-Galetová, and Sablin 2012). While the recovered human skeletons were destroyed in World War II, finely detailed photographic negatives allowed comparisons to other human groups (Figure 12.15). The Předmostí crania were more globular than those of archaic humans but tended to be longer and lower than in later modern humans (Velemínská et al. 2008). The height of the face was in line with modern residents of Central Europe. One standout trait seen on every mandible on this site was an unusually long length to the mandibular body and jutting chin, resulting in a particular local appearance. Besides the human remains, the site contained the bones of over a thousand mammoths. Some of the mammoth remains were shaped by humans, including a limb bone fragment with a carved abstract female figure. There is also skeletal evidence of dog domestication, such as the presence of dog skulls with shorter snouts than in wild wolves (Germonpré, Lázničková-Galetová, and Sablin 2012). In total, Předmostí could have been a settlement dependent on mammoths for subsistence with people participating in artistic behaviors and the artificial selection of early domesticated dogs.

Figure 12.15 This illustration is based upon one of the surviving photographic negatives since the original fossil was lost in World War II. The modern human chin is prominent, as is an archaic occipital bun.

Upper Paleolithic European Material Culture

The sequence of modern *Homo sapiens* technological change in the Later Stone Age has been thoroughly labeled and dated by researchers working in Europe. The style associated with the start of the Upper Paleolithic is the Aurignacian, starting around 40,000 years ago and ending around 27,000 years ago. Items in this tradition include stone blades as well as beads made from shell, bones, and teeth. Next is the Gravettian, which lasted from 6,000 years to 21,000 years ago. This culture is associated with most of the known curvy female figurines, often assumed to be "Venus" figures. Hunting technology also advanced, such as with the first known boomerang, **atlatl** (spear thrower), and archery. The Solutrean, marked by further innovation in delicate tool work, is the following style from 21,000 to 17,000 years ago. After that time, the Magdalenian tradition spread. This culture further expanded on fine bone tool work, including barbed spearheads and fishhooks (Figure 12.16). The end of the Magdalenian is also the end of the Later Stone Age and the Pleistocene Period. While these labels and time spans apply to Europe, other regions also showed changes in material culture to some of the same types of technology. Uncovering the regional timelines of cultural styles around the world to see these transitions on a global scale is an ongoing goal of paleoanthropologists.

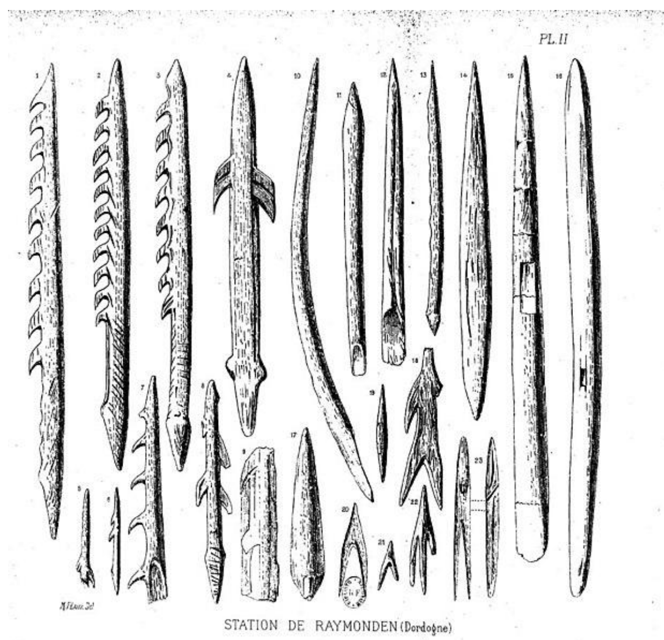

Figure 12.16 This drawing from 1891 shows an array of Magdalenian-style barbed points found in the burial of a reindeer hunter. They were carved from antler.

Among the many European sites dating to the Later Stone Age, the famous cave art sites deserve mention. Chauvet-Pont-d'Arc Cave in southern France dates to separate Aurignacian occupations 31,000 years ago and 26,000 years ago. Over a hundred art pieces representing 13 animal species are preserved. Some depicted species are common to European cave art, such as deer and horses. Others are rare, such as rhinos and owls. Two possible human figures are in the deepest gallery of the cave system. Besides the painted figures, the tracks and skulls of cave bears and an ibex were also found in the cave. Another famous French cave with art is Lascaux, which is several thousand years younger at 17,000 years ago in the Magdalenian period. At this site, there are over 6,000 painted figures on the walls and ceiling (Figure 12.17). The paint was made of a mix of mineral pigments in liquid binder made from fat or clay. Scaffolding and lighting must have been used to make the paintings on the walls and ceiling deep in the cave. Overall, visiting Lascaux as a contemporary must have been an awesome experience: trekking deeper in the cave lit only by torches giving glimpses of animals all around as mysterious sounds echoed through the galleries. The professionally lit photographs of today do not give the original context justice, though replicas have been built to simulate the experience for tourists. Both Chauvet and Lascaux have been closed to all but researchers due to the degradation of the art when tourism was allowed.

Figure 12.17 Photograph of just one surface with cave art at Lascaux Cave. The most prominent piece here is the Second Bull, found in a chamber called the Hall of Bulls. Smaller cattle and horses are also visible.

Summary of Modern H. sapiens *in Europe*

Study of Europe in the Upper Paleolithic gives a more detailed view of the general pattern of biological and cultural change linked with the arrival of modern *Homo sapiens*. The modern humans experienced a rapidly changing culture that from our perspective went through four major growths in complexity and refinement. Skeletally, the increasing globularity of the cranium and the gracility of the rest of the skeleton continued, though with unique regional traits, too. The cave art sites showed a deeper use of expression and symbolism, though the exact meaning is unclear. With survival dependent on the surrounding ecology, painting the figures may have connected people to important and impressive wildlife at both a physical and spiritual level. Both reverence for animals and the use of caves for an enhanced sensory experience are common to cultures today and through recorded history.

In the next section we continue our exploration of *Homo sapiens* origins by seeing the genetic evidence of interbreeding between the archaic and modern types, leaving just the latter to continue to the present day.

Distant Relations: Interbreeding with Archaic Humans Outside Africa

As the modern human population grew beyond Africa, they interbred with the archaic *Homo sapiens* who were already there, descendants of the *Homo erectus* populations before them. This statement is different from what many people in the public believe: that modern humans are the direct descendants of the archaic Neanderthals. Instead, the building evidence suggests a more complex connection between archaic and modern humans outside of Africa. This section describes the evidence showing that three *Homo sapiens* groups interbred with one another: modern *Homo sapiens* and two archaic groups, the Neanderthals and the Denisovans (Figure 12.18).

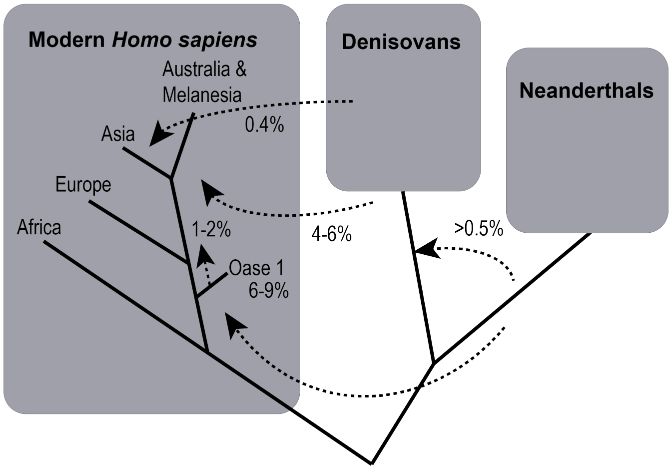

Figure 12.18 This diagram shows the amount of DNA introgression between Neanderthals, Denisovans, and various regional lineages of modern Homo sapiens. The 6–9% Neanderthal DNA found in the modern human Oase 1 was narrowed down to 1–2% in later modern humans. Denisovans share a few percent of their DNA with modern Australasians and Melanesians but just a fraction of a percent with modern East Asians.

Interbreeding with Neanderthals

Since the first finds of Neanderthal remains, researchers have sought evidence of a biological connection with modern Europeans. While there are no sites that show Neanderthals and modern *Homo sapiens* lived together (such as both types of skeletons found together in a common burial), interbreeding has been suggested by the appearance of Neanderthal traits in otherwise modern human skeletons found in their common geographical range. For example, the Oase 2 cranium from Peștera cu Oase and the Skhul V cranium each had a partial occipital bun between the Neanderthal and modern extremes.

A new source of evidence arrived with the invention of ancient DNA (aDNA) analysis, which has built up more evidence of Neanderthal and modern human interbreeding. DNA samples from Neanderthal fossils have been compared to DNA from both prehistoric and present-day modern *Homo sapiens* to trace the amount of gene flow between these groups. The amount of transfer is more indicative of **introgression**, the entrance of small, uneven portions of Neanderthal DNA into modern humans, rather than an even hybridization over time (Dannemann and Racimo 2018; Slatkin and Racimo 2016). The introgression could have been caused by an imbalance in population size: the continually growing modern population with gene flow from Africa could have diluted the incoming Neanderthal DNA to the low percentage seen today. The time spent apart as separate lineages could have caused genetic incompatibility, especially in the Y chromosome (Mendez et al. 2016). Natural selection may also have removed the inherited Neanderthal alleles if they were maladaptive, leaving just the adaptive or neutral variants.

Continuing DNA analyses reveal more details about interbreeding. Geneticist Fu Qiaomei and her team (2015) revealed long sections of Neanderthal DNA in Oase 1, around 6%–9% of the total amount, suggesting a Neanderthal ancestor four to six generations before. Fu also found continuous sections of Neanderthal DNA in the DNA of Russian and Siberian modern humans from around 45,000 years ago, reinforcing the genetic evidence of interbreeding (Fu et al. 2014).

The findings of Neanderthal DNA analysis and comparison with modern human genomes worldwide have revealed surprising details about the interactions between these groups. An unexpected result is that modern Asians have more DNA from Neanderthals than modern Europeans despite the separation in geography (Wall and Yoshihara Caldeira Brandt 2016). Today, non-Africans have around 1%–2% Neanderthal DNA in their genomes, with Asians having more than Europeans. This is a drop from the amount found in Oase 1. One explanation for this finding is that the interbreeding between Neanderthals and modern humans happened in the Middle East before the population split into the modern European and Asian populations. Then Neanderthal DNA introgressed at least a second time just into the Asian population, leaving more in that group.

Interbreeding with Denisovans

Comparison of DNA between the Denisovan archaic humans and modern humans has also produced intriguing information about the interaction between these groups. Denisovan DNA has also introgressed into some modern human populations (Reich et al. 2010; Reich et al. 2011). In this case, neither modern Africans nor Europeans have any Denisovan DNA. There is around 0.4% in modern East Asians. Notably, most modern Tibetans inherited a Denisovan allele that produces an adaptation to high-altitude living (Huerta-Sánchez et al. 2014). The highest amount is in some modern Melanesians and aboriginal Australians, between 4% and 6%. Though the Denisovan sample came from the Altai Mountains in Siberia, the most likely location for the interbreeding based on the DNA evidence was in East Asia or Sunda. The ancestors of the Melanesians and Australians would have received the Denisovan DNA into their genomes there before their descendants expanded to their eventual destinations.

Summary of Archaic Human Genetic Introgression

While the study of skeletal traits suggested archaic-modern interbreeding, the use of DNA analysis provided solid evidence of these events between archaic and modern *Homo sapiens* in Europe and Asia. This is a very active field as the technology keeps improving and more samples are analyzed. A consistent picture is forming, but many of the details concerning the timing and context of interbreeding are still unclear. At this point, we know that three human groups interbred with each other at different times. DNA originating from Neanderthals and Denisovans was found in prehistoric modern humans and is present in some Europeans and Asians of today. The introgressed DNA has affected the traits of our own species and they are just being discovered.

African Developments

We now switch our view back to Africa to see what developments occurred after members of our species first crossed to the Middle East and beyond. Our survey of modern *Homo sapiens* expansion left Africa around 150,000 years ago to see where people pushed the fringes of our geographical range. It is important to remember the species did not all leave Africa together. While modern humans found ways to survive in the Middle East, Asia, Sahul, and Europe, many others remained in Africa. Evidence of what *Homo sapiens* did in Africa from the end of the Middle Stone Age to the Later Stone Age is concentrated in South African sites. There, Blombos Cave and Border Cave show that complex human behavior was also developing in the home continent.

Blombos Cave is located along the present shore of the Cape of Africa facing the Indian Ocean and is notable for having a wide variety of artifacts. The material culture shows that toolmaking and artistry were more complex than previously thought for the Middle Stone Age. Excavations and analysis have been carried out since the 1990s by a research team including Francesco d'Errico, Christopher Henshilwood, and Marian Vanhaeren. In a layer dated to 100,000 years ago, researchers found two intact ochre-processing kits made of abalone shells and grinding stones (Henshilwood et al. 2011). Chemical analysis found the likely ingredients of the ochre-based paint, including crushed bone, animal fat, and charcoal. More ochre fragments, including some marked with notches, were found all throughout the site. The team performed numerous analyses and experiments to show that perforated marine snail shell beads from 75,000 years ago were shaped by people using bone points found in the cave (Figure 12.19) (d'Errico et al. 2005). Together, the evidence shows that the Middle Stone Age occupation at Blombos Cave incorporated resources from a variety of local environments into their culture, from caves (ochre), open land (animal bones and fat), and the sea (abalone and snail shells). This complexity shows a deep knowledge of the region's resources and their use–not just for survival but also for symbolic purposes.

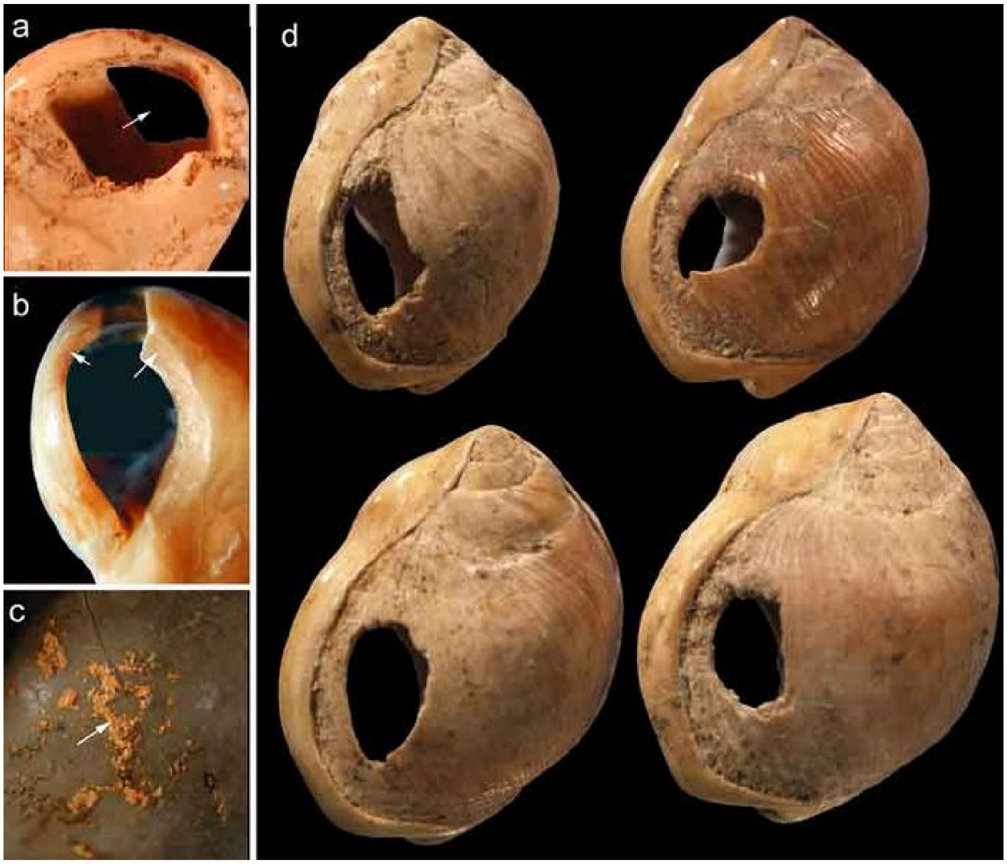

Figure 12.19 Examples of the perforated shell beads found in Blombos Cave, South Africa: (a) view of carved hole seen from the inside; (b) arrows indicate worn surfaces due to repetitive contact with other objects, such as with other beads or a connecting string; (c) traces of ochre; and (d) four shell beads showing a consistent pattern of perforation.

On the eastern coast of South Africa, Border Cave shows new African cultural developments at the start of the Later Stone Age. Paola Villa and colleagues (2012) identified several changes in technology around 43,000 years ago. Stone tool production transitioned from a slower, measured process to one that took less time to finish but made many **microliths**, small stone tools. An adhesive made from tree bark was found on some of the microliths. The researchers hypothesize that hunting technology moved from large crafted spearheads to smaller bone arrow points that were adhered to shafts and even tipped with poison for more effectiveness. Changes in decorations were also found across the Later Stone Age transition. Beads were made from a new resource: fragments of ostrich eggs (d'Errico et al. 2012). Unlike the snail shell beads, which retained the shape of the original structure, ostrich shell beads were shaped into circular forms, resembling present-day breakfast cereal O's. While a subtle difference, these beads show a higher level of altering one's own surroundings and a move from the natural to the abstract in terms of design.

Summary of Continuing Modern H. sapiens *in Africa*

African culture experienced a long constant phase called the Middle Stone Age until a faster burst of change produced innovation and new styles. The change was not one moment but rather a ramping up in development. Later Stone Age culture introduced elements seen across many cultures, including the construction of composite tools and even the use of strung decorations such as beads. These developments appear in the Later Stone Age of other regions, such as with the Balangoda of Sri Lanka and the Aurignacian tradition of Europe, both mentioned above. Based on the early date of the African artifacts, Later Stone Age culture may have originated in Africa and passed from person to person and region to region, with people adapting the general technique to their local resources and viewing the meaning in their own way.

Unfortunately, information about modern humans in Africa from 40,000 to 12,000 years ago is scarce. In the next section, we will return to the expanding frontier as the first hominins set foot in the Western Hemisphere.

Discovering the Americas

By 20,000 years ago, our species was the only member of Homo left on Earth. Gone were the Neanderthals, Denisovans, and *Homo floresiensis*. The range of modern *Homo sapiens* kept expanding eastward into—using the name given to this area by Europeans much later—the Western Hemisphere. This section will address what we know about the peopling of the Americas, from the first entry to these continents to the rapid spread of prehistoric Native Americans (referred to by researchers without intentional insult as prehistoric **Amerindians**, **Paleoindians**, or **Paleoamericans**) across its lush and varied environments.

The Changing Role of Beringia

Evidence points to a prehistoric land bridge called **Beringia** that allowed people to cross from Asia to North America, just as expansion to Australia was made easier with lowered sea levels that exposed Sunda and Sahul. Beringia connected what is now northeastern Siberia with Alaska. What people did to cross this land bridge is still being investigated. Currently there are two competing models for this event, called the **Ice-Free Corridor model** and the **Coastal Route model**, though the latter has been gaining intriguing evidence.

For most of the 20th century, the accepted theory was that prehistoric northeast Asians (East Asians and Siberians) first expanded across Beringia inland through an ice-free corridor between glaciers that opened into the western Great Plains of the United States, just east of the Rocky Mountains, around 13,000 years ago (Swisher et al. 2013). While life up north in the cold environment would have been harsh, migrating birds and an emerging forest might have provided sustenance as generations expanded through this land (Potter et al. 2018). These residents would have used a stone tool style that developed into the common Clovis style found later in North America.

In recent decades, researchers accumulated evidence against the ice-free corridor as the original path the first Native Americans took. For example, some archaeological sites around the Americas date to a time before the corridor was open. While one site with a date that contradicts the model could be dismissed as an error at first, several more sites were found that brought more scrutiny to the Ice-Free Corridor model. The route between glaciers was available later, and was likely used at that time, but there was already a more accessible path between the hemispheres.

The reconstruction of past geography, climate, and ecology led to the formation of the Coastal Route model that explains how people reached the Americas through Beringia. The new focus is the southern edge of the land bridge instead of its center: About 16,000 years ago, members of our species expanded along the coastline from northeast Asia, east through Beringia, and south down the Pacific Coast of North America while the inland was still sealed off by ice. Archaeologist K. R. Fladmark (1979) brought the Coastal Route model into the archaeological spotlight and researcher Jon M. Erlandson has been at the forefront of compiling support for this theory (Erlandson et al. 2015). Reconstructing the geography and climate of Beringia, the coast would have been free of ice at least part of the year by 16,000 years ago, earlier than when the ice-free corridor was completely opened. Studies of past ecology found that the coastal route would have provided abundant plant and animal resources for most of the path. Besides migrating birds, many useful fish (e.g., salmon), shellfish, mammals (e.g., whales, seals, and otters), and plants (e.g., seaweed) would have been available on the coast. A refinement of this model called the **Kelp Highway hypothesis** focuses on one particular ecosystem found just offshore from Japan, north to Beringia, and south to Baja California. This addition states that subsisting off of resources from kelp forests could have supported the rapid expansion to the Americas and down the coast of the two continents.

Other lines of evidence are also compatible with the Coastal Migration model. One indirect archaeological connection between prehistoric Japan and the Americas is a certain style of stone tool. Coastal tanged or stemmed lithics, which are stone points with a thin projection at the base, have been found in both of these distant regions (Erlandson and Braje 2011). The similarity could indicate a cultural tie. Genetic analysis of Native American DNA also shows shared ancestry with northeast Asians, linking them biologically as well (Raghavan et al. 2014).

While many factors such as reconstructions of climate and ecology indirectly support the Coastal Migration model, the search continues for direct evidence such as archaeological sites along the route. Due to the warming trend since 18,000 years ago that reduced glaciers and raised the sea level, much of the prehistoric coast that would have been occupied by the first coastal migrants to North America is currently over 100 meters underwater (Erlandson et al. 2015).

Researchers are also still determining how many large waves of people made the crossing through either Beringian route. A four-field analysis of modern Native American languages found evidence of three migration events, resulting in three major language groups (Greenberg 1987). Analyzing the DNA of prehistoric and modern peoples, which was not possible in Greenberg's time, researchers found evidence for one large wave of gene flow from Beringia, with major splits once in North America (Raghavan et al. 2015). Smaller waves after the main one could also have moved from Beringia to North America. As far back as 23,000 years ago, people living in Beringia would have had lowered gene flow with northeast Asians and also been unable to expand further east. This concept of a period of genetic isolation based on DNA analysis is called the **Beringia Standstill Model**. It explains the amount of genetic differences between Native Americans and northeast Asians within the time frame of the other evidence.

South through the Americas

However the first modern *Homo sapiens* reached the Western Hemisphere, the spread through the Americas was rapid. Multiple migration waves crossed from North to South America (Posth et al. 2018). Our species took advantage of the lack of hominin competition and the bountiful resources both along the coasts and inland. The Americas had their own wide array of megafauna, which included woolly mammoths, mastodons, camels, horses, ground sloths, giant tortoises, and—a favorite of researchers—a two-meter-tall beaver (Figure 12.20). The reason we cannot find these amazing animals today may be that Paleoindians hunted them all to extinction. Resources gained from these fauna must have been an important part of survival for people over 12,000 years ago (Araujo et al. 2017). Several sites are notable for what they add to our understanding of American prehistory, including interactions with megafauna and other elements of the environment.

Figure 12.20 Lifesize reconstruction of a woolly mammoth at the Page Museum, part of the La Brea Tar Pits complex in Los Angeles, California. Outside of Africa, megafauna such as this went extinct around the time that humans entered their range.

Monte Verde is a landmark site that shows that the human population had expanded down the whole vertical stretch of the Americas to Chile by 14,600 years ago, only a few thousand years after humans first entered the Western Hemisphere from Alaska. The site has been excavated by archaeologist Tom D. Dillehay and his team (2015), revealing fragile material culture that is rarely preserved, including human footprints, animal hides, and wooden tools. Two of the discoveries at Monte Verde relate to the Coastal Migration model. The discovery of nine edible species of seaweed at the site shows familiarity with coastal resources that might have been passed down through generations of experience living near the ocean. A stemmed point, reminiscent of the coastal styles, was also among the lithics at Monte Verde (Figure 12.21).

Figure 12.21 A stemmed point (left) and drill fragment (right) found in the same level at Monte Verde. The stemmed point resembles a coastal Andean style called the Paiján and may be evidence supporting the Coastal Route model.

Named after the town in New Mexico, the Clovis stone tool style is the first example of a widespread culture across much of North America, between 13,400 and 12,700 years ago (Miller, Holliday, and Bright 2013). Instead of a stem-shaped base, Clovis points were fluted with two small projections, one on each end of the base, facing away from the head (Figure 12.22). The stone points found at this site match those found as far as the Canadian border and northern Mexico, and from the west coast to the east coast of the United States. Fourteen Clovis sites also contained the remains of mammoths or mastodons, suggesting that hunting megafauna with these points was an important part of life for the Clovis people. Other Clovis sites show that other types of hunting and gathering were important to people's subsistence, too. After the spread of the Clovis style, it diversified into several regional styles, keeping some of the Clovis form but also developing their own unique touches.

Figure 12.22 Compared to the stemmed point in Figure 12.21, this Clovis point has a drastically different structure. The Clovis point has a wider tip and the base has two small projections instead of a single large stem. This example was carved from chert and found in north central Ohio, dated to around 11 kya.

Only one site has a human burial containing Clovis tools: Anzick in western Montana. The individual, Anzick-1, is a male infant dated to 12,800 years ago (Rasmussen et al. 2014). He was buried with over 100 Clovis stone and bone tools that were coated in ochre. Genetic analysis found that Anzick-1's people were related to all later Native Americans, proving a direct ancestral connection and supporting the model of one large wave of migrants populating the Americas with Paleoindians.

Summary of Modern H. sapiens *in the Americas*

Research in prehistoric Native American origins found some surprising details, refining older models. Genetically, the migration can be considered one long period of movement, with splits into regional populations. This finding matches the sudden appearance of the homegrown Clovis culture, its rapid expansion, and the radiation of descendant cultures in North America. A few thousand years after arrival into the hemisphere, people had already covered the Americas from north to south.

The peopling of the Americas also had a lot of common elements with the prior spread of humans across Africa, Europe, Asia, and Australia. In all of these expansions, people explored new lands that tested both the cultural and biological adaptations of the pioneers. Besides stone tool technology, the use of ochre as decoration was seen from South Africa to South America. The coasts and rivers were likely avenues in the movement of people, artifacts, and ideas, outlining the land masses while providing access to varied environments. The presence of megafauna aided human success, but this resource was eventually depleted in many parts of the world.

With our tracing of human expansion across the continents complete, we will see how researchers visualize what we learned about the origin and dispersal of modern *Homo sapiens* from 315,000 to 12,000 years ago.

The Big Picture: The Assimilation Model

How do researchers make sense of all of these modern *Homo sapiens* discoveries that cover over 300,000 years of time and stretch across every continent except Antarctica? How was modern *Homo sapiens* related to archaic *Homo sapiens*? Over the past few decades, paleoanthropologists have engaged in spirited debates based on their interpretation of the data. In the mid- to late 20th century, scientists had split into two competing views. This section describes this episode of paleoanthropology history and how continuing scientific research improves our view of the world.

One competing model was called the **Out of Africa model** or Recent African Origin model. Supporters of this model saw evidence that modern *Homo sapiens* first evolved in Africa, then expanded into the other continents without interaction with the archaic *Homo sapiens* of Europe and Asia (Stringer and Andrews 1988). Researchers on this side noted that the oldest modern *Homo sapiens* fossils were found in Africa, suggesting that that continent was the origin. Genetic analysis found the same conclusion.

The other model was called **Multiregionalism** or the Multiregional Continuity model. The view of the data by scientists on this side was that modern *Homo sapiens* evolved from the archaic humans in Africa, Europe, and Asia simultaneously (Wolpoff 1989). Gene flow would have kept the species cohesive across the great distance while producing local variation as well. The multiregionalist experts pointed to the sharing of traits from *Homo erectus*, through archaic *Homo sapiens*, and then to the modern humans in different parts of the world as supporting their model. For example, in Europe the Oase modern humans possessed Neanderthal-like traits and certain modern humans possess alleles that came from Neanderthals and Denisovans.

Eventually, researchers noticed that both the Out of Africa model and the Multiregionalism model had elements that were supported by data and elements that were not supported. Taking the supported parts of each model and combining them formed an explanation that was more complicated, but explained much more of the scientific evidence. The merging of two models to form a better one suits the name of the improved version: the Assimilation model.

The **Assimilation model** proposes that modern *Homo sapiens* evolved in Africa first and expanded out (from the Out of Africa model) but also interbred with the archaic *Homo sapiens* they encountered outside Africa (from the Multiregionalism model) (Figure 12.23). True multiregionalism occurred just within Africa as the species evolved from a web of interactions between varied groups (Scerri et al. 2018). As the modern human population expanded from Africa, they assimilated the alleles of archaic humans they encountered through interbreeding. The Assimilation model is powerful since it explains why Africa has the oldest modern human fossils, why early modern humans found in Europe and Asia bear a resemblance to the regional archaics, and why traces of archaic DNA can be found in our genomes today (Smith et al. 2017).

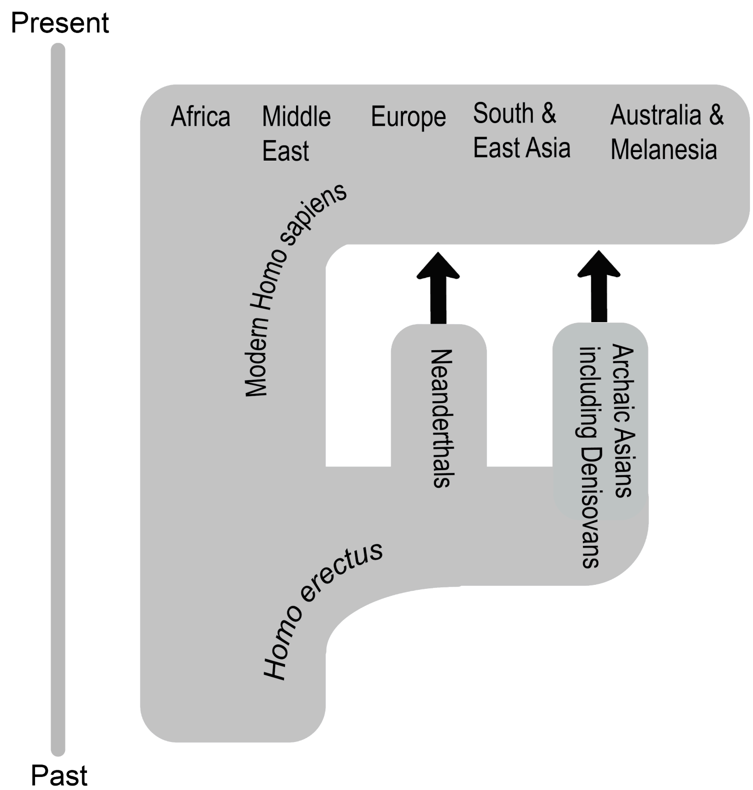

Figure 12.23 This diagram depicts the connections between archaic and modern Homo sapiens of different regions. Having evolved from Homo erectus, the archaic humans expanded from Africa and established the Neanderthal and Denisovan groups. In Africa, the remaining archaic humans evolved the modern set of traits and expanded from the continent as well, encountering and interbreeding with two archaic groups across Europe and Asia.

While scientific progress has produced a model that satisfies the data, there are still a lot of questions for paleoanthropologists to answer regarding our origins. What were the patterns of migration in each part of the world? Why did the archaic humans go extinct? In what ways did archaic and modern humans interact? How large were the past populations? How did biological, cultural, and environmental factors influence the material culture found in different parts of the world? The definitive explanation of how our species started and what our ancestors did is still out there to be found. You are now in a great place to welcome the next discovery about our distant past—maybe you'll even contribute to our understanding as well.

Special Topics: "Cavemen" in Popular Culture

"Cavemen," or our prehistory in general, is a constant presence in western popular culture. From the iconic opening to 2001: A *Space Odyssey* to the less iconic 10,000 B.C., the distant past is a common setting for dramatic stories. The prehistoric experience even gets interactive with games like *Far Cry Primal* where the player can persistence-hunt for food and ride a woolly mammoth (!) (Figure 12.24). The distant past has also been the setting for more comedic stories, such as *The Flintstones* and, recently, *The Croods* with Nicolas Cage.

Figure 12.24 Screenshot of an action scene from the videogame Far Cry Primal. While the game is set at 12 kya, one faction of humans has distinctly Neanderthal traits (center-left), though none were left by that time in reality. Note touches inspired by research, such as the use of shells for decoration on the protagonist's wrist.

Why are we interested in the past beyond a scientific understanding? Like feudal times or the Wild West, prehistory may be a setting that is rife for telling stories that excite us. With humanity stripped of the modern conveniences we are used to, situations become more intense. Prehistory takes this trope to the extreme. The viewer/game player is invited to think about what they would do if they had to live more directly off of the environment, unshielded from the dangers of the natural world. Experiencing our imaginings of that time may satisfy parts of our brain that evolved in that situation, just as people accustomed to urban life find enjoyment by camping or sitting around a fire with friends and family. Seeing the portrayal of the prehistoric world may reach those parts of our psychology that feel at home away from our constructed environment.

That said, the portrayal of the past in fiction is rarely accurate. There is a significant lag time between the scientific view of our past and when it reaches mass media. Older works age very poorly. In *Clan of the Cave Bear*, a book from 1980, the Neanderthals have limited emotions and communicate with sign language rather than speaking: two ideas that have not stood the test of time but were core to the story. Even in recent productions, prehistoric people are dim-witted and have limited vocabulary, though the evidence shows that our brains and language abilities are basically the same today as 300,000 years ago. How our media choose to represent the past may say more about our own values and views of ourselves rather than what people were actually like long ago.

As you engage in the next fiction set in our distant past, consider how the presentation differs from the scientific view and why there is this divide. Also, as you enjoy the world that is presented to you, consider that we are not so different from the cavemen. We are the ones born into the world of projectors and streaming media, and we may build on that to create the next medium, but at our core we are the same as the painters of Lascaux and the carvers of prehistoric figurines.

THE CHAIN REACTION OF AGRICULTURE

While it may be hard to imagine today, for most of our species' existence we were nomadic: moving through the landscape without a singular home. Instead of a refrigerator or pantry stocked with food, we procured nutrition and other resources as needed based on what was available in the environment. Instead of collecting and displaying stuff, we kept our possessions at a minimum for mobility. This part gives an overview of how this foraging lifestyle enabled the expansion of our species, then describes the invention of a new way of life, causing a chain reaction of cultural change taking us to the present day and beyond.

The Foraging Tradition

To understand our species is to understand **foraging**, or the search for resources in the environment. This **subsistence strategy**, or method of finding sustenance, sounds unusual to most of us today. Most of us live in cultures that practice another strategy, **agriculture**, where we shape the environment to mass produce what we need. Considering the age of modern *Homo sapiens*, however, we have spent far more time as nomadic foragers than as settled agriculturalists. As such, our traits have evolved to be primarily geared toward foraging. For instance, our efficient bipedalism allows persistence-hunting across long distances as well as movement from resource to resource. Even our psychological tendency toward our ability to form stable relationships with around 150 people (Dunbar 1993) may derive from the foraging lifestyle.

How does human foraging, also known as hunting and gathering, work? Anthropologists have used all four fields to answer this question (see Ember n.d.). Typically, people formed **bands**, or groups of around 50, and rarely over 100. A band's organization would be **egalitarian**, with a flexible hierarchy based on an individual's age, level of experience, and relationship with others. Everyone would have a general knowledge of the skills assigned to their gender roles, rather than specializing in different occupations. A band would move from place to place in the environment, using knowledge of the area to hunt and gather (Figure 12.25). While there were exceptions, women typically gathered plants and hunted small animals while men hunted larger prey where present (Waguespack 2005). The ratio of plant to meat in one's diet would have depended on the local resources. As a location's resources became used up, and as human waste accumulated, the band would travel to another patch (Venkataraman et al. 2017). In the varied environments that humans entered—from savannas to tropical forests, deserts, coasts, and the Arctic circle—people found sustenance needed for survival. Our species's omnivorous and cultural ability led us to excel in the generalist-specialist niche. People could have temporarily altered their environment to be more productive, such as by burning foliage to spur new growth. Besides food sources, people would have known the local areas to find rock and wood suitable for tool production, and ochre for decoration. Bands could have formed trading connections to acquire goods from distant areas. Certain sites could have been gathering spots for local bands to trade, socialize, and worship, though they were not typically large permanent settlements.

Figure 12.25 A present-day San man in Namibia demonstrates hunting using archery. Anthropologists still study the San today to learn about the foraging lifestyle in Africa.

Humans made extensive use of the foraging subsistence strategy, but this lifestyle did have limitations. The ease of foraging depended on the richness of the environment. Due to the lack of storage, resources had to be dependably found when needed. While a bountiful environment would require just a few hours of foraging a day, the level and duration of labor increased greatly in poor or unreliable environments. Labor was also needed to process the acquired resources, contributing to filling the foragers' daily schedule (Crittenden and Schnorr 2017).

The adaptations to foraging found in modern *Homo sapiens* may explain why our species became so successful both within Africa and in the rapid expansion around the world. Overcoming the limitations, each generation at the edge of our species's range would have found it beneficial to expand a little further, keeping contact with other bands but moving into unexplored territory where resources were richer. The cumulative effect would have been the spread of modern *Homo sapiens* across continents and hemispheres.

Why Agriculture?

After hundreds of thousands of years of foraging, some groups of people around 12,000 years ago started to practice agriculture instead. This transition is called the **Neolithic Revolution**, and it occurred at the start of the **Holocene** epoch. The reasons for this global change are still being investigated, but there are two likely causes that may have occurred together: a growing human population and natural global climate change.

Overcrowding could have affected the success of foraging in the environment, leading to the development of a more productive subsistence strategy (Cohen 1977). Foraging works the best with low population densities since each band needs a lot of space to support itself. If too many people occupy the same environment, they would deplete the area faster. The high population could exceed the **carrying capacity**, or number of people a location can reliably support. For instance, what if a band arrived at a grove of nutritious plants they were depending on, but it had already been used by other groups? Then the late arrivals are suddenly in a dire situation without the food they were depending on finding. This situation on a global level due to growing population and limited areas of expansion would have been an increasingly pressing issue after the human expansion through the major continents by 14,600 years ago.

A changing global climate immediately preceded the transition to agriculture, so researchers have also explored a connection between the two events. Since the **Last Glacial Maximum** of 23,000 years ago, the Earth slowly warmed. At 13,000 years ago, the temperature in most of the Northern Hemisphere dropped suddenly in a phenomenon called the **Younger Dryas**. Glaciers returned in Europe, Asia, and North America. In Mesopotamia, which includes the Levant, the climate changed from warm and humid to cool and dry. The change would have occurred over decades, disrupting the usual nomadic patterns and subsistence of foragers around the world. The Younger Dryas lasted until 11,700 years ago, when the climate returned to the long-term warming pattern. The disruption to foragers due to the temperature shift could have been a factor in spurring the transition to agriculture. Researchers Gregory K. Dow and colleagues (2009) believe that foraging bands would have clustered in the new resource-rich places where people started to direct their labor to farming the limited area. Continued practice would prompt innovations such as better tools and increasing productivity. After the Younger Dryas ended, people expanded out of the clusters. As they reinhabited the region, they brought with them a culture in which farming had become the norm, along with the technology and knowledge to succeed with this subsistence strategy (Figure 12.26).

The double threat of the limitation of human continental expansion and the sudden global climate change may have placed bands in peril as more populations outpaced their environment's carrying capacity. Not only had a growing population led to increased competition with other bands, but environments worldwide shifted to create more uncertainty. As people in different areas around the world faced this chaotic situation, they became the independent inventors of agriculture.

Figure 12.26 Rice farmers in the present day using draft cattle to prepare their field.

Agriculture around the World

Due to global changes to the human experience starting from 12,000 years ago, cultures with no knowledge of each other turned toward farming their local resources (Figure 12.27). The switch to agriculture took time and effort with no guarantee of success. Agriculture is a difficult process with fires, floods, droughts, disease, and pests being constant problems to address. Heavy physical labor with no immediate payoff was also needed to shape the landscape in a coordinated way to support agriculture. For example, people had to direct water flow to irrigate constructed fields of crops. The first farmers also engaged in artificial selection of their domesticates to enhance useful traits. The biggest success stories in the face of these obstacles became the primary centers of agriculture (Figure 12.27) (Fuller 2010):

- Mesopotamia: The Fertile Crescent from the Tigris and Euphrates rivers through the Levant was where bands started to domesticate plants and animals around 12,000 years ago. The connection between the development of agriculture and the Younger Dryas was especially strong here. Farmed crops included wheat, barley, peas, and lentils. This was also where cattle, pigs, sheep, and goats were domesticated.
- South and East Asia: Multiple regions across this land had varieties of rice, millet, and soybeans by 10,000 years ago. Pigs were farmed with no connection to Mesopotamia. Chickens were also originally from this region, bred for fighting first and food second.
- New Guinea: An under-appreciated center in Melanesia, agriculture started here 10,000 years ago. Bananas, sugarcane, and taro were native to this island. Sweet potatoes were brought back from voyages to South America around the year C.E. 1,000. No known animal farming occurred here.
- Mesoamerica: Agriculture from Central Mexico to northern South America also occurred from 10,000 years ago; it was also only plant based. Maize was a crop bred from teosinte grass, which has become one of the global staples. Beans, squash, and avocados were also grown in this region.
- The Andes: Starting around 8,000 years ago, local domesticated plants started with squash but later included potatoes, tomatoes, beans, and quinoa. Maize was brought down from Mesoamerica to join the local variety. The main farm animals were llamas, alpacas, and guinea pigs.
- Sub-Saharan Africa: This region went through a change 5,000 years ago called the Bantu expansion. The Bantu agriculturalists were established in West Central Africa and then expanded south and east. Native varieties of rice, yams, millet, and sorghum were grown across this area. Cattle were also domesticated here.
- Eastern North America: This region was the last major independent agriculture center, from 4,000 years ago. Squash and sunflower are the produce from this region that are most known today, though sumpweed and pitseed goosefoot were also farmed. Hunting was still the main source of animal products.

By 5,000 years ago, our species was well within the Neolithic Revolution. From the primary centers, agriculturalists spread to neighboring parts of the world with their domesticates, further expanding the use of this subsistence strategy. For example, the Mesopotamian farmers spread their innovations along the northern coast of the Mediterranean into Europe (Pinhasi, Fort, and Ammerman 2005). The crops of China were brought into the Korean peninsula (Lee 2011). From this point, the human species changed from being primarily foragers to primarily agriculturalists. The revolution took millennia, but it was a true revolution in that the lifestyle of our species was reshaped to something vastly different.

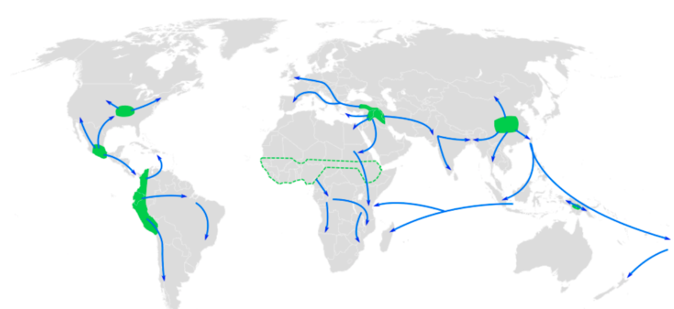

Figure 12.27 Map showing the areas where agriculture was independently invented around the world. The dotted line around sub-Saharan Africa represents a possible range that is still being narrowed by research. Blue arrows show the spread of agriculture from these zones to other regions.

Cultural Effects of Agriculture

The worldwide adoption of agriculture altered the course of human culture and history forever. The foraging lifestyle was incompatible with agriculture, so dependence on the latter required huge changes in how people lived. This section starts by following the human developments that occurred due to agriculture, leading us from 12,000 years ago to the present day. We will also reconnect with modern foragers to see how their lives have changed.

The core change in human culture due to agriculture is the move toward not moving: rather than live a nomadic lifestyle, farmers had to remain in one area to tend to their crops and livestock. The term for living bound to a certain location is **sedentarism**. Remaining in one place led to aspects of life that were uncommon in foragers: the construction of permanent shelters and agricultural infrastructure such as fields and irrigation, plus the development of storage technology such as pottery to preserve extra resources in case of future instability.

The high productivity of successful agriculture sparked further changes (Smith 2009). Since successful agriculture produced a much greater amount of food and other resources per unit of land compared to foraging, the population growth rate skyrocketed. The surplus of a bountiful harvest also provided insurance for harder times, reducing the risk of famine. Changes happened to society as well. With a few farming households producing enough food to feed many others, other people could focus on other tasks. So began specialization into different occupations such as craftspeople, traders, religious figures, and artists, spurring innovation in these areas as people could now devote time and effort toward specific skills. These interdependent people would settle an area together for convenience, causing a rise in the number of dense populations focused around farms, water, and trade routes. The growth of these settlements led to **urbanization**, the founding of cities that became the foci of human interaction.

Figure 12.28 View of downtown San Diego taken by the author at a shopping complex during a break from jury duty. Here, people live amongst structures that facilitate commerce, government, and art.

The formation of cities led to new issues that sparked the growth of further specializations, called **institutions**. These were cultural constructs that existed beyond the individual and had wide control over a population. Leadership of these cities became hierarchical with different levels of rank and control. Laws influenced the behavior of citizens, establishing ideal behavior and punishment for deviations. Organized religion also kept followers under a standard set of beliefs and values tied to spirituality. Under leadership, people built impressive **monumental architecture** such as pyramids that embodied the wealth and power of these early cities. Alliances could unite cities, forming the earliest states. In several regions of the world, state organization expanded into empires, wide-ranging political entities that covered a variety of cultures.

Urbanization brought new challenges as well. The concentration of sedentary peoples was ideal for infectious diseases to thrive since they could jump from person to person and even from livestock to person (Armelagos, Brown, and Turner 2005). Urban life also caused sanitation problems as human waste accumulated, adding to the spread of disease. While successful agriculture provided a large surplus of food to thwart famine, the variety of food produced was smaller than what foragers experienced (Cohen and Armelagos 1984; Cohen and Crane-Kramer 2007). The dependence on high-yield crops also caused an overabundance of carbohydrates in the diet of agriculturalists. This shift in nutrition caused another set of diseases to flourish among those who adopted farming as their subsistence strategy: dental issues such as **dental caries** (the cavities that ruin your visit to the dentist) and **malocclusion** (the misalignment of teeth caused by the softness of agricultural diets). The issues with "wisdom teeth" or third molars seen in agricultural cultures today stems from this misalignment between the environment our ancestors adapted to and our lifestyles today.

As the new disease trends show, the adoption of agriculture and the cultural changes that followed were not entirely positive. It is also important to note that this is not an absolutely linear progression of human culture from simple to complex and that higher complexity is not necessarily better than lower complexity. In many cases empires have collapsed and cities have dispersed to low-density bands that no longer saw use in maintaining institutions. However, a global trend has emerged since the adoption of agriculture, wherein population and complexity have increased, leading to the massive and influential nation states of today.

The rise of states in Europe has a direct impact on many of this book's topics. Science started as a European cultural practice by the upper class that became a standardized way to study the world. Education became an institution to provide a standardized path toward producing and gaining knowledge. The scientific study of human diversity, embroiled in the race concept that still haunts us today, was connected to the European slave trade and colonialism.

Also starting in Europe, the Industrial Revolution of the 19th century turned cities into centers of mass manufacturing and spurred the rapid development of inventions. In the technologically interconnected world of today, human society has reached a new level of complexity with **globalization**. In this system, goods are mass produced and consumed in different parts of the world due to worldwide economic factors. Instead of relying on local farms and factories, we now receive our everyday goods from all over the world.

As states based on agriculture and industry keep exerting influence on humanity today, there are people who continue to live a foraging—or mostly foraging—lifestyle. Due to the overwhelming force that agricultural societies could exert, foragers today have been marginalized to live in the least habitable parts of the world (Headland et al. 1989). These are places that are the worst for farmland, such as tropical rainforests, deserts, and the arctic. Foragers can no longer live in the abundant environments that humans would have enjoyed before the Neolithic Revolution. Interactions with agriculturalists are typically imbalanced, with trade and other exchanges heavily favoring the larger group. One of anthropology's important roles today is to intelligently and humanely manage interactions between people of different backgrounds and levels of influence.

Figure 12.29 This combine harvester can collect and process grain at a massive scale. Our food now commonly come from enormous farms located around the world.

The Future of Humanity

This chapter covered what modern *Homo sapiens* has done to get to the present time, but what will our species do far in the future? Just as biological changes accumulated from over 300,000 years ago to today, what will human traits and genetics be like? When posed with these questions, people tend to think of directional selection. Maybe our braincases will be even larger, resembling the large-headed and small-bodied aliens of science fiction (see figure 12.30. Or, our hands could be specialized for interacting with our touch-based technology with less risk of repetitive injury. These ideas do not stand up to scrutiny. Since natural selection is based on adaptations that increase reproductive success, any directional change must be due to a higher rate of producing successful offspring compared to other alleles. Larger brains and more agile fingers would be convenient to possess, but they do not translate into an increase in the underlying allele frequencies.

Figure 12.30 Will we evolve toward even more globular brains? Actually, this trend is not likely to continue for our species.

Scientists are hesitant to professionally speculate on the unknowable, and we today will never know what is in store for our species a thousand or a million years from now, but there are trends in human evolution that may carry on into the future. These trends are increased genetic variation and a reduction in regional differences.

Rather than a directional change, genetic variation in our species could expand. Our technology can protect us from extreme environments and pathogens, even if our biological traits are not tuned to handle these stressors. The rapid pace of technological advancement means that biological adaptations will become less and less relevant to reproductive success, so non-beneficial genetic traits will be more likely to remain in the gene pool. Biological anthropologist Jay T. Stock (2008) views environmental stress as needing to defeat two layers of protection before affecting our genetics. The first layer is our cultural adaptations. Our technology and knowledge can cover for many of our biological issues, reducing pressure on one's genotype to be just right to pass to the next generation. The second defense is our flexible physiology, such as our functional adaptations. Only stressors not handled by these powerful responses would then cause natural selection on our alleles. These shields are already substantial, and cultural adaptations will only keep increasing in strength.

The increasing ability to travel far from one's home region means that there will be a mixing of genetic variation on a global level in the future of our species. In recent centuries, gene flow of people around the world has increased, creating admixture in populations that had been separated for tens of thousands of years. For skin color, this means that populations all around the world could exhibit the whole range of skin colors, rather than the current pattern of decreasing melanin pigment farther from the equator. The same trend of intermixing would apply to all other traits, such as blood types. While our genetics will become more varied, the variation will be more intermixed instead of regionally isolated.

Our distant descendants will not likely be dextrous ultra-intellectuals; more likely, they will be a highly variable and mobile species. They will be supported by cultural adaptations that we cannot even imagine, making up for any biological limitations that keep getting passed to the next generation. Technology may even enable the editing of DNA directly, changing these trends. With the uncertainty of our future, these are just the best educated guesses for now. Our future is open and will be shaped little by little by our actions and those of our descendants.

CONCLUSION

Modern *Homo sapiens* is the species that took the hominin lifestyle the furthest to become the only living member of that lineage. This last section of the chapter summarizes what we know about modern *Homo sapiens* traits, origins, and history.

The largest factor that allowed us to persist while other hominins went extinct was likely our advanced ability to culturally adapt to a wide variety of environments. Our species, with its skeletal and behavioral traits, was well suited to be generalist-specialists who successfully foraged across most of the world's environments. The biological basis of this adaptation was our reorganized brain that facilitated innovation in cultural adaptations and intelligence for leveraging our social ties. As the brain's ability increased, it shaped the skull by reducing the evolutionary pressure to have large teeth and robust cranial bones to produce the modern *Homo sapiens* face.

Our ability to be generalist-specialists is seen in the geographical range that modern *Homo sapiens* covered in 300,000 years. In Africa, our species formed from multiregional gene flow that loosely connected archaic humans across the continent. People then expanded out to the rest of the continental Old World and even further to the Americas. Wherever people went, they were enabled and connected by the shared tools and art they crafted.

For most of our species's existence, foraging was the general subsistence strategy within which people specialized to culturally adapt to their local environment. With biologically endowed omnivorousness and mobility, people found ways to extract and process resources, shaping the environment in return. When global fluctuation in climate and a sudden resource uncertainty hit the species, people around the world focused on agriculture to have a firmer control of necessities. The new strategy shifted human history toward exponential growth and innovation to address the drastic shift in lifestyle, leading to our high dependence on cultural adaptations today. We may continue this trend in the future, with global changes to human genetic diversity.

While a cohesive image of our species has formed in recent years, there is still much to learn about our past. The work of many driven researchers shows that there are amazing new discoveries made all the time that refine our knowledge of human evolution. Technological innovations such as DNA analysis enable scientists to approach lingering questions from new angles. The answers we get allow us to ask even more insightful questions that will lead us to the next revelation. Like the pink limestone strata at Jebel Irhoud, previous effort has taken us so far and you are now ready to see what the next layer of discovery holds.

Review Questions

- What are the skeletal and behavioral traits that define modern *Homo sapiens*? What are the evolutionary explanations for its presence?
- What are some creative ways that researchers have learned about the past by studying fossils and artifacts?
- How do the discoveries mentioned in "First Africa, Then the World" fit the Assimilation model?
- What is foraging and what adaptations do we have for this subsistence strategy? Could you train to be a skilled forager?
- What are aspects of your life that come from dependence on agriculture and its cultural effects? Where did the ingredients of your favorite foods originate from?

Key Terms

African multiregionalism: The idea that modern *Homo sapiens* evolved as a complex web of small regional populations with sporadic gene flow among them.

Agriculture: The mass production of resources through farming and domestication.

Amerindian: Term used to refer to the ancient humans of North and South America.

Assimilation model: Current theory of modern human origins stating that the species evolved first in Africa and interbred with archaic humans of Europe and Asia.

Atlatl: A handheld spear thrower that increased the force of thrown projectiles.

Band: A small group of people living together as foragers.

Beringia: Prehistoric landmass that connected Siberia and Alaska. The ancestors of Paleoindians would have crossed this area to reach the Americas.

Beringia Standstill Model: Theory that people were genetically isolated in Beringia before expanding to the Americas.

Carrying capacity: The amount of organisms that an environment could reliably support.

Coastal Route model: Theory that the first Paleoindians crossed to the Americas by following the southern coast of Beringia.

Dental caries: Damage to tooth enamel due to the waste products of built-up bacteria. Known in the general public as cavities.

Early Modern *Homo sapiens*, Early Anatomically Modern Human: Terms used to refer to transitional fossils between archaic and modern *Homo sapiens* that have a mosaic of traits. Humans like ourselves, who mostly lack archaic traits, are referred to as Late Modern *Homo sapiens* and simply Anatomically Modern Humans.

Egalitarian: Human organization without strict ranks. Foraging societies tend to be more egalitarian than those based on other subsistence strategies.

Foraging: Lifestyle consisting of frequent movement through the landscape and acquiring resources with little storage.

Generalist-specialist niche: The ability to survive in a variety of environments by developing local expertise. Evolution toward this niche may have been what allowed modern *Homo sapiens* to expand past the geographical range of other human species.

Globalization: A recent increase in the interconnectedness and interdependence of people facilitated with long-distance networks.

Globular: Having a rounded appearance. Increased globularity of the braincase is a trait of modern *Homo sapiens*.

Gracile: Having a smooth and slender quality; the opposite of robust.

Holocene: The epoch of the Cenozoic Era starting around 12,000 years ago and lasting arguably through the present.

Ice-Free Corridor model: Theory that the first prehistoric Native Americans crossed to the Americas through a passage between glaciers.

Institutions: Long-lasting and influential cultural constructs. Examples include government, organized religion, academia, and the economy.

Introgression: The uneven mixing of DNA over time in which a small amount of outside genetic material is incorporated into a larger genome.

Kelp Highway hypothesis: Addition to the Coastal Route model that focuses on the use of kelp-based environments as a resource.

Last Glacial Maximum: The time 23,000 years ago when the most recent ice age was the most intense.

Later Stone Age: Time period following the Middle Stone Age with a diversification in tool types, starting around 50,000 years ago.

Levant: The eastern coast of the Mediterranean. The site of early modern human expansion from Africa and later one of the centers of agriculture.

Malocclusion: The misalignment of the jaw due to the soft diets of agriculturalists. The healthy development of the jaw, including making room for all of the teeth, depends on experiencing a higher level of physical force than what people experience with farmed and processed foods. The term literally means "bad shutting."

Megafauna: Large prehistoric animals that may have been hunted to extinction by people around the world.

Mental eminence: The chin on the mandible of modern *H. sapiens*. One of the defining traits of our species.

Microlith: Small stone tool found in the Later Stone Age; also called a bladelet.

Middle Stone Age: Time period known for Mousterian lithics that connects African archaic to modern *Homo sapiens*.

Monumental architecture: Large and labor-intensive constructions that signify the power of the elite in a sedentary society. A common type is the pyramid, a raised crafted structure topped with a point or platform.

Mosaic: Composed from a mix or composite of traits.

Multiregionalism: Theory that modern *Homo sapiens* evolved simultaneously in Africa, Asia, and Europe from archaic populations.

Neolithic Revolution: Time of rapid change to human cultures due to the invention of agriculture, starting around 12,000 years ago.

Ochre: Iron-based mineral pigment that can be a variety of yellows, reds, and browns. Used by modern human cultures worldwide since at least 80,000 years ago.

Out of Africa model: Theory that modern *Homo sapiens* expanded from Africa to cover the rest of the world without interacting with archaic humans.

Paleoamerican, Paleoindian: Terms used to refer to the ancient humans of North and South America.

Sahul: Prehistoric landmass connecting New Guinea and Australia.

Sedentarism: Lifestyle based on having a stable home area; the opposite of nomadism.

Southern Dispersal model: Theory that modern *H. sapiens* expanded from East Africa by crossing the Red Sea and following the coast east across Asia.

Subsistence strategy: The method an organism uses to find nourishment and other resources.

Sunda: Asian prehistoric landmass that incorporated modern Southeast Asia.

Supraorbital torus: The bony brow ridge across the top of the eye orbits on many hominin crania.

Upper Paleolithic: Time period considered synonymous with the Later Stone Age.

Urbanization: The increase of population density as people settled together in cities.

Wallacea: Archipelago southeast of Sunda with different biodiversity than Asia.

Younger Dryas: The rapid change in global climate, especially a cooling of the Northern Hemisphere, 13,000 years ago.

About the Author

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Dr. Keith Chan is an instructor of anthropology at Grossmont College and MiraCosta College in San Diego County. He reached this step of his anthropological path after many memorable experiences across the country and the hemisphere. He earned a bachelor's degree in anthropology from the University of California, Berkeley, in 2001. As a graduate student at the University of Missouri, he traveled to Perú with teams of students to study prehistoric skeletons to understand the lives of prehistoric Andeans. He completed his writing to earn a Ph.D. in 2011. Inspired by many educators in his journey, Dr. Chan turned his career toward teaching anthropology and helping students understand and appreciate humanity.

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