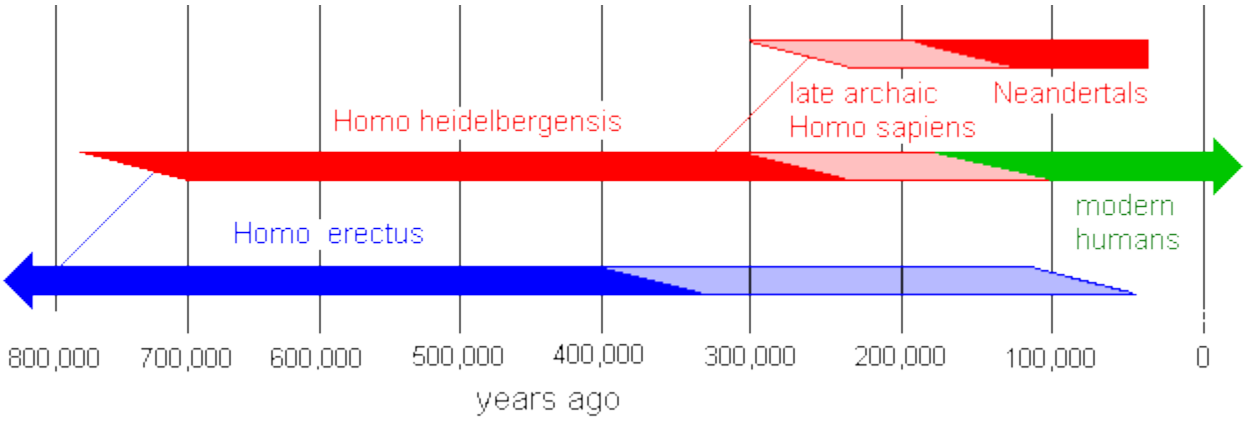
Homo heidelbergensis

The evolutionary dividing line between *Homo erectus* and modern humans was not sharp. It extended over several hundred thousand years during the middle of the Pleistocene Epoch. Adding to the confusion about this important transitional period is the fact that some regions were ahead of others in the process of evolving into our species. The evolutionary changes above the neck that would lead to modern humans may have begun in Southern Europe and East Africa 800,000-700,000 years ago. Elsewhere in the Old World, this change apparently began around 400,000 years ago or later. The transition to our species, *Homo sapiens* ,was not complete until around 100,000 years ago and even later in some regions.

Archaic humans

It is difficult to speak of our ancestors in terms of specific species during this long period of accelerated change from 800,000 to 100,000 years ago. The more biologically progressive post-800,000 B.P. populations in Europe and Africa are commonly classified as a distinct species--***Homo heidelbergensis*** . By 300,000 years ago, some of these populations had begun the evolutionary transition that would end up with **Neandertals** and other **archaic humans** (also called archaic *Homo sapiens* and premodern humans). By 100,000 years ago, some populations had evolved into **modern humans**. Others remained largely unchanged until about 28,000 years ago, when they became extinct. These were the Neandertals. Complicating the picture is the fact that, in at least one area of Indonesia, a few *Homo erectus* remained until at least 53,000 years ago, and the little understood dwarf *Homo floresienses* persisted until at least 18,000 years ago.

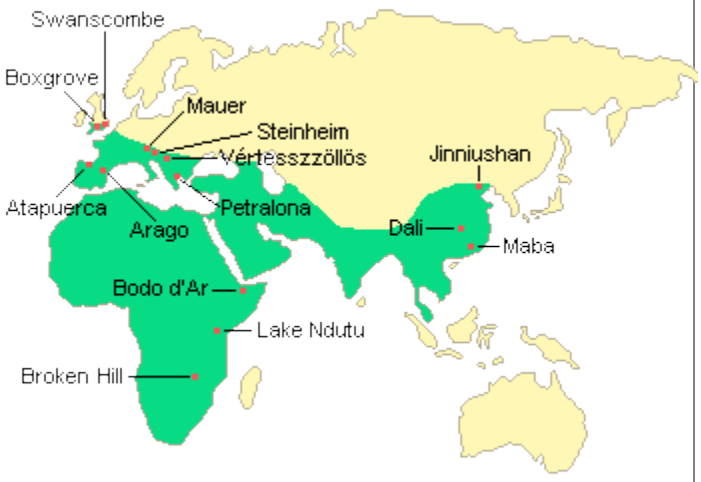


Homo heidelbergensis was named for a jaw of this species discovered near the town of Mauer, southeast of Heidelberg, Germany in 1907. Since then, fossils of *Homo heidelbergensis* have been found throughout the Old World from tropical to temperate zones. These widespread populations show regional variations in physical appearance. The extent of the interaction between these diverse and widely distributed populations is not clear. Likewise, there is not yet agreement as to which of these populations were the ancestors of modern humans. However, it is apparent that in all regions, these people were anatomically a mosaic of late *Homo erectus* and modern human traits.

Homo heidelbergensis
(Petralona Cave, Greece)

With an average of 1206 cm.^{3}, the *heidelbergensis* brains were only 10% smaller than people today, but their heads did not have a modern appearance. They had large brow ridges and low foreheads. Their brain cases also were more elongated from front to back than in *Homo sapiens* today. In these characteristics, *heidelbergensis* was still more like *Homo erectus* than us.

Important Homo heidelbergensis Sites



	Date of Fossil (years ago)	Cranial Capacity (in cm.^{3})
Africa:		
Bodo d'Ar	600,000	1300
Broken Hill (Kabwe)	700,000-400,000?	1280
Lake Ndutu	400,000-250,000?	1100
China:		
Dali	200,000-100,000	1120
Jinniushan	280,000	1260
Maba	169,000-129,000	
Europe:		
Arago Cave	450,000	1150
Atapuerca	800,000-400,000	1125-1390
Boxgrove	524,000-478,000	
Ehringsdorf	245-190,000	1450
Mauer	500,000	
Petralona Cave	400,000-250,000	1230
Steinheim	400,000-300,000	1100
Swanscombe	400,000	1325?
Vértesszöllös	475,000-250,000	1400?

Note: There is not a general agreement at this time as to how *Homo heidelbergensis* fossils should be classified. Some paleoanthropologists prefer to classify the more recent ones as archaic humans or archaic *Homo Sapiens*. Likewise, some of the earliest *Homo heidelbergensis* are classified as *Homo antecessor or even* late transitional *Homo erectus*.

NEWS: What may be the earliest known human footprints have been found on the slope of Roccamonfina volcano in Italy. The three sets of footprints and a handprint surviving in hardened volcanic ash were made 385-325,000 years ago presumably by archaic humans. *Based on the size of the footprints, it was estimated that they were made by someone who was not quite 5 feet tall. While these may be the earliest known human footprints, they are not the earliest known hominin ones. That honor goes to the 3.7-3.5 million year old footprints at the Laetoli site in Tanzania. More information about the 385-325,000 year old Italian footprints may be found in the March 13, 2003 issue of Nature.*

NEWS: Eudald Carboneli et al. reported in the March 27, 2008 issue of Nature that a human jaw with a tooth dating 1.2-1.1 million years ago has been found in Sima del Elefante cave in the Atapuerca Mountains of Northern Spain. This is the oldest fossil evidence of humans yet discovered in Western Europe. The authors believe that they are from an early Homo antecessor (i.e., Homo heidelbergensis).

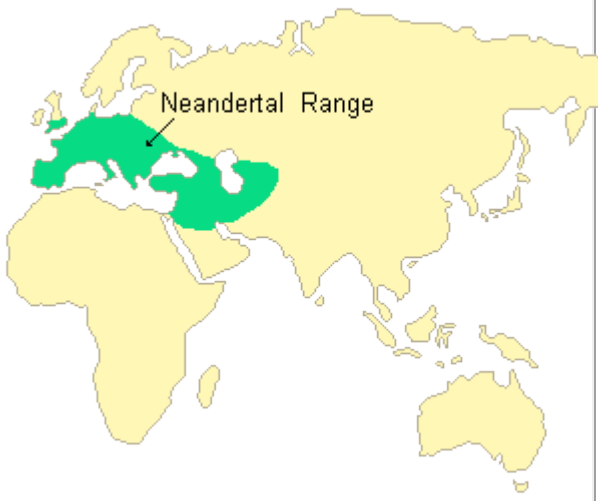
Neandertals


Neandertal hunters

The most well-known late archaic humans were the **Neandertals**. More Neandertal skeletons have been found than any other ancient human species. They lived in Europe and Southwest Asia from about 130,000 years ago until at least 28,000 years ago. This is in the late Pleistocene Epoch. It is likely that the Neandertals evolved from *Homo heidelbergensis* in Southern Europe. Neandertal-like skull characteristics have been found in 400,000 year old fossils from Spain. The Neandertals adapted physically and culturally to the ice age conditions that prevailed during much of their time.

No other ancient people have aroused more controversy and confusion over the last century and a half than have the Neandertals. In fact, there is an on-going debate as to whether they should even be considered *Homo sapiens*. If they were members of our species, they were a different variety or race (*Homo sapiens neanderthalensis*). On the other hand, if they were dissimilar enough to be a distinct species, they should be called *Homo neanderthalensis*.

Important Neandertal Sites



	Date of Fossil (years ago)
Croatia:	
Krapina	130,000-120,000
Vindija	38,000
France:	
La Ferassie	75,000-60,000
La Chapelle-aux-Saints	56,000 or 47,000
La Quina	75,000-40,000
Le Moustier	40,000
St Césaire	36,000
Germany:	
Neandertal	40,000
Gibraltar:	
Forbe's Quarry	70,000-45,000?
Gorham's Cave	32,000-24,000

	Date of Fossil (years ago)
Italy:	
Saccopastore	129,000-122,000?
Mt. Circeo	60,000-55,000
Iraq:	
Shanidar	46,000
Israel:	
Tabun	103,000-80,000
Kebara	60,000
Amud	55,000-47,000
Romania:	
Peştera Muierii	32,000
Peştera cu Oase	30,000
Spain:	
El Sidrón	43,000

Neandertal Discoveries

The first discovery of Neandertal bones may have been during the late 1820's in Western Europe. Subsequently, other, better documented Neandertals were found and stored in museums without being recognized as early forms of humans. In 1839, for instance, a portion of a child's skeleton was found in Engis, Belgium. In 1848, an adult female skull was found at Gibraltar, at the southern tip of Spain.

In 1856 a discovery was made in Germany that finally sparked the recognition that these were, in fact, not just strange looking modern people. This was the discovery of a skull and a number of other bones from a limestone cave deposit in the small Neander River Valley near Düsseldorf. Thinking that they were from a bear, the quarrymen gave them to a local school teacher and amateur naturalist, **Johan Karl Fuhlrott**. He recognized them as being human but somewhat different from those of modern Europeans. When several leading paleontologists and medical pathologists in Germany became aware of the fossils, a disagreement developed about who the "Neandertal Man" might have been. It was suggested that he had been an old Roman, a Dutchman, and even a Central Asian soldier in the service of the Russian czar during the Napoleonic wars of the early 19th century. The reality that these bones were from an earlier variety or species of human was not yet conceivable to most of the scientific world in the 1850's.

Johan Karl Fuhlrott
1803-1877

What finally convinced the scientific community that Neandertals were very ancient Europeans was a combination of additional fossil discoveries and new perspectives that largely began with the publication of Charles Darwin's *On the Origin of Species* in 1859. This seminal work in biology popularized the idea that species of living things evolve over time as a result of natural selection. Subsequently, it was not a major leap in understanding to realize that humans also must have evolved from earlier forms. In fact, Darwin proposed just that in his 1871 influential publication *Descent of Man*. For enlightened Victorians, the Neandertals ultimately came to be seen as important human ancestors. They were given the name "Neandertal Man" in 1864 by William King, an Irish anatomist. He named them after the Neander River Valley (or *Tal*, in German).

NOTE: In many older books, Neandertal is spelled with a "thal" ending (Neanderthal). This is the Old German spelling that was replaced in the early 20th century. However, this antiquated usage persists in some English publications. It is also continued in the scientific designation (Homo sapiens neanderthalensis).

In 1886, two Neandertal skeletons were found in a Belgium cave site named **Spy**. These specimens were physically associated with food refuse bones from extinct subarctic animals as well as stone tools that were somewhat more advanced than those of the Acheulian tradition used by *Homo erectus*. This evidence once and for all demonstrated that Neandertals were not modern people. As a result, the majority of European paleontologists in the late 1880's finally accepted them for what they really were.

Marcellin Boule
1861-1942

The remains of more than 400 Neandertals have been found. The most controversial one was excavated in 1908 at **la Chapelle-aux-Saints** in southwestern France. This is a nearly complete skeleton of a man who would have been elderly by Neandertal standards. The bones were analyzed between 1911 and 1913 by the noted French paleontologist, **Marcellin Boule**. Unfortunately, Boule's prejudices got in the way of scientific objectivity. He described the La Chapelle-aux-Saints man, and subsequently all Neandertals, as dull-witted, brutish, ape-like creatures who walked hunched over with a shuffling gait. Unfortunately, this mistaken view was universally accepted by paleoanthropologists for decades. It also became the source of the popular images of dim-witted cavemen that still appear in cartoons and movies.

Diorama of Neandertals in an American Museum during the 1930's reflecting the misconception reinforced by Marcellin Boule's description of them as dull-witted, brutish, ape-like creatures.

After reanalysis of the La Chapelle-aux-Saints skeleton in the 1950's, it became clear that a serious mistake had been made. This had been an atypical Neandertal. He was at least 40 years old with a somewhat hunched over posture resulting from severe arthritis in his spine. There was a bowing of his legs that may have resulted from rickets disease in childhood. He had lost most of his teeth and part of his jaw resulting in a disharmonic looking face. Despite these deforming infirmities, it is now clear that the La Chapelle-aux-Saints man was much more like us in appearance than had been believed by Marcellin Boule.

La Chapelle-aux-Saints man

Analysis of Neandertal Anatomy

The Neandertals were physically diverse, but in general they were larger boned and more heavily muscled than most modern humans. This was particularly true of the European Neandertals, like

the La Chapelle-aux-Saints man. Some of the Southwest Asian Neandertals were less robust in appearance and somewhat more like modern humans. The Neandertals were relatively short and stocky compared to some other archaic humans and modern Europeans. Adult male Neandertals averaged just over 5 feet tall. They probably stood as erect as we do and were fully bipedal. They were not only strong but apparently quite flexible. The thickness and high density of their leg bones suggests that they did a great deal of walking and running. These traits were likely adaptations to an aggressive hunting and gathering way of life as well as to the cold climates in which most Neandertals lived. The fact that adult Neandertal skeletons frequently have multiple healed bone fractures suggests that these people had rough lives. Some researchers believe that many of the broken bones were the result of hunting large game animals up close with jabbing spears--a dangerous enterprise.

Neandertal heads were long (from front to back) compared to ours. This resulted in relatively low, sloping foreheads. At the back of their skulls, they had a prominent bulge or projection called an **occipital bun**. They had large faces with big noses and prominent brow ridges that extended between the eyes. They lacked the pointed chin that is common in modern *Homo sapiens*. These traits give the Neandertal face and head an appearance more reminiscent of late *Homo erectus* and *Homo heidelbergensis* than of modern people.

Neandertal Modern human

The brain size of Neandertals was close to that of modern humans, and the structural organization of their brains was essentially the same as well. The average Neandertal brain was actually somewhat larger than the brains of most people today. However, the difference is minimal when people of similar body size are compared. In fact, the average Neandertal brain may have been slightly smaller from this perspective. The large heads and massive but short bodies of Neandertals very likely were more efficient in cold climates and were probably selected for by nature. This trend has been observed among contemporary Native American populations living in sub-arctic environments. A larger head and more compact body shape potentially produce more body heat relative to the amount that is lost to the environment through radiation. A bigger brain carries a high energy overhead. The human brain uses around 20% of the energy that we get from our food when we are resting, but it is only 2% of our body mass. This is one reason that the brains of new-born humans are only about 25% the size of those of adults. It is hard for a pregnant woman's body to feed her own brain and that of her baby at the same time. It is even more difficult when there are twins.

Comparison of Cranial Capacities

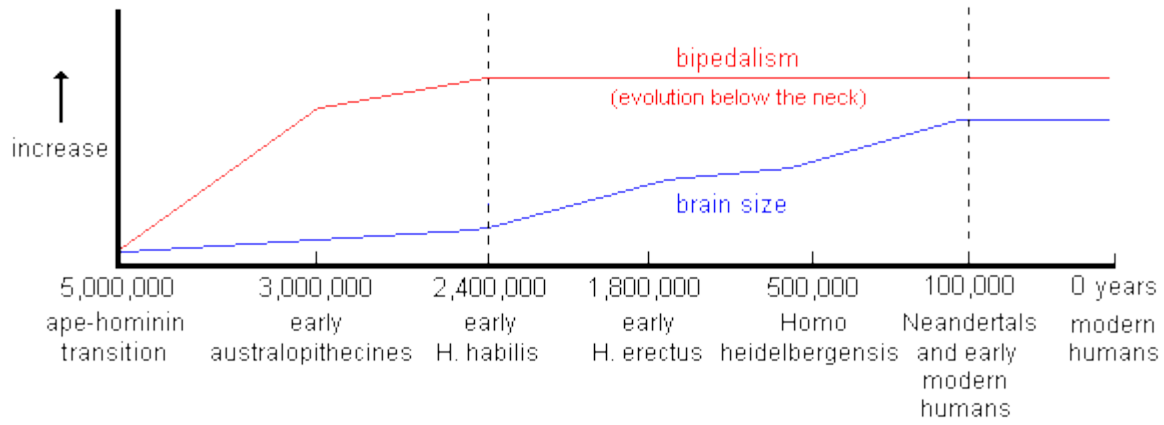
	range (cm^3)	**average** (cm^3)
chimpanzees	300-500	----
australopithecines	390-545	----
Homo habilis	509-752	610
Homo erectus	750-1250	970
Homo heidelbergensis	1100-1390	1206
Neandertals	1300-1750	1450
modern *Homo sapiens*	900-1880	1345

Note: There is a considerable range in body size among modern *Homo sapiens,* including large numbers of small people. Subsequently, the average brain size is smaller than would initially seem likely. However, the average for some modern populations (especially European and most African ones) is slightly larger than that of Neandertals.

Female Neandertal brains were about 200 cm^3 smaller than those of males. This sexual dimorphism should not be a surprise since female bodies were smaller. Modern human female brains are about 10% smaller than those of males for the same reason.

NOTE: It would be a mistake to assume that a minor difference in overall brain size is directly correlated with intelligence among archaic or modern humans. However, the gross difference in cranial capacity between the earliest human species and recent Homo sapiens probably does reflect potential intelligence differences. In order to trace the development of intelligence, speech, and other mental capabilities, it is more useful to examine changes in specific brain regions and the genes that control their development.

It is now clear that upright bodies and bipedal locomotion long preceded the evolution of the large human brain. The early 20th century speculation that our ancestors would be large brained apes proved to be incorrect. We attained the full human form of bipedalism by about 2.5 million years if not earlier. However, the size of our brains continued to increase in a punctuated evolutionary pattern. There apparently was a period of comparative stasis beginning around 1.8 million years ago. However, by 800,000-600,000 years ago, human brain size began to grow very rapidly. This skyrocketing trend continued until around 100,000 years ago or a bit earlier.



In other words, there was a mosaic pattern of evolution. We continued to evolve above the neck after the rest of the body essentially reached its modern form. This process of the brain increasing in size over and beyond that explainable by an increase in body size has been referred to as **encephalization**. The overall increase in brain size was, in fact, mostly a result of changes in particular regions of the cerebrum, where most high level brain functions occur. It is likely that nature was selecting for the mental capabilities needed to adapt rapidly to new environments. The brain was being neurally reorganized for processing complex information. This can be seen indirectly in the evolution of culture. Progressively more sophisticated stone tools are, in effect, the material remains of encephalization.

Who Were the Neandertals and What Happened to Them?

We are still left with the question of whether Neandertals were members of our species or another species with whom we share a distant common ancestor. Two conflicting sources of evidence have shed light on this issue. This evidence is in the form of genes and bones.

In 2004, researchers from the Max Planck Institute for Evolutionary Anthropology in Germany completed tests for the presence of intact mitochondrial DNA (mtDNA) in skeletal material from 24 Neandertals and 40 early modern *Homo sapiens*. They found it in 4 of the Neandertals and 5 of the early modern humans. These individuals lived 60,000-30,000 years ago in Central and Western Europe. The nucleotide sequences that were analyzed indicated that early modern humans were significantly different genetically from Neandertals. It was estimated that only about 25% of the Neandertal mtDNA sequences were shared with their early modern human contemporaries. This was verified in 2008 when the first complete mtDNA genome of a Neandertal was recorded. Within a few years, researchers at the Max Planck Institute hope to have a draft of the entire nuclear genome of Neandertals as well. It will be compared with modern humans to see where we differ. Based on the data accumulated so far, it is estimated that the Neandertals diverged from the evolutionary line leading to modern humans about 660,000 ± 140,000 years ago. This DNA evidence supports the contention that Neandertals were not a subspecies or variety of our species and that they were not our ancestors.

Critics have pointed out that the DNA differences between Neandertals and modern humans could be accounted for by genetic drift causing rapid changes in gene pool frequencies and that *Homo sapiens* living at their time might not have been very different from them genetically. Additional evidence came to light as a result of the 1999 discovery of a 4 year old child's skeleton in Portugal dating to 24,500 years ago. He had a mixture of Neandertal and modern human anatomical characteristics suggesting that he had been a hybrid. This was 3-4,000 years after the last known Neandertal. The implication is that some of the Neandertals interbred with modern humans resulting in gene flow between the populations. If that is true, then the genetic difference between us and them must not have been as great as would be expected between two distinct species. In other words, this would suggest that the Neandertals were a variety of *Homo sapiens* rather than a distinct species and that at least some people from Europe and possibly Southwest Asia may share Neandertal genes.

The size of the total Neandertal population was never very large and appears to have diminished steadily beginning around 35,000 years ago. The last secure date for a Neandertal site was about 28,000 years ago. What happened to them is not clear. However, their relatively abrupt disappearance roughly coincides with the arrival and rapid growth in numbers of modern humans in Europe. A common view is that Neandertals could not compete effectively with the technologically more advanced and numerically larger new-comer population. Stephen Kuhn and Mary Stiner of the University of Arizona suggest an alternative hypothesis. They believe that modern humans entered Europe with cultures having a division of labor that was less risky for pregnant women, mothers, and young children. They think that women mostly collected vegetables, fruits, and nuts, while men concentrated on the far more hazardous task of hunting animals. The occasional loss of men in hunting accidents would not have significantly affected birth rates and the survival of children. As a consequence, there would have been a steady growth in the size of modern human populations. In contrast, Kuhn and Stiner believe that both men and women among the Neandertals were involved in the dangerous hunting of big game animals with weapons that required close encounters with their prey. As a result, their populations were kept low and relatively uncompetitive.

Another provocative hypothesis to explain the disappearance of Neandertals has been proposed by Leslie Aiello of University College London. It is connected with the fact that Neandertals progressively became scarcer as Europe moved into the coldest phase of the last ice age. She suggests that Neandertal habitation sites were limited to areas in which winter temperatures did not go below 0° F. (-18° C.) because their technology was not up to dealing with harsher conditions. These relatively warmer areas would have become more and more isolated pockets as the climate cooled, especially after 30,000 years ago. Eventually, they would have disappeared and the Neandertals within them would have perished from the cold. Aiello believes that the modern humans living in Europe at that time survived because their technology for dealing with extreme ice age conditions was superior. This hypothesis provides a logical explanation with supporting evidence for the disappearance of most but not all Neandertals. It does not explain why the Neandertals living in the comparatively warmer areas of Southwest Asia also became extinct. It also is based on the questionable assumption that Neandertals were not smart or inventive enough to develop adequate technology for severe cold winter conditions. However, it is true that the known Neandertal sites that were occupied after 30,000 years ago were in the relatively warmer southern European regions of Spain and Gibraltar.

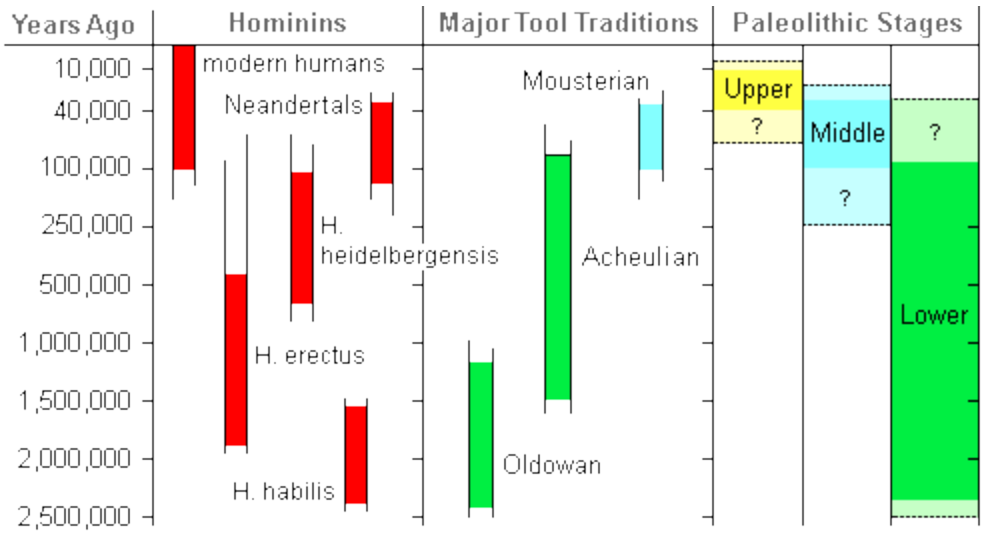
Regardless of how they are classified or what happened to them, it has now become clear that the Neandertals were the first humans to live successfully in subarctic environments of the northern hemisphere during at least the milder phases of an ice age. They first appeared in Europe during an interglacial when the climate was similar to today. With the onset of the last ice age about 75,000 years ago, some Neandertals may have migrated to Southwest Asia (at least to Israel and Iraq) where it was warmer. However, others adapted to the increasingly severe climatic conditions of Europe. They did this primarily with new cultural inventions discussed in the next section of this tutorial.

NEWS: Clive Finlayson of the Gibraltar Museum reported in the September 6, 2006 issue of Nature that there was a Neandertal occupation of Gorham's Cave in Gibraltar from 32,000 to 24,000 years ago. He believes that Neandertals and modern humans lived simultaneously in Gibraltar and nearby areas of Southern Spain for several thousand years. If his radiocarbon dates are correct, it means that Neandertals persisted in Southern Europe for upwards of 4,000 years after they are generally thought to have disappeared.

NEWS: Carles Lalueza-Fox et.al. reported in the October 25, 2007 issue of Science that at least some Neandertals had pale skin color and red hair. This is based on the discovery of a variant of the MC1R gene associated with these traits in the bones of two European Neandertals dated to around 50,000 years ago. This was very likely an adaptation that helped their bodies produce more Vitamin D and subsequently absorb more calcium from their food in ice age Europe.

Archaic Human Culture

The cultures of prehistoric humans are known mostly through the excavation of stone tools and other relatively imperishable artifacts. The early tool making traditions are often referred to as being paleolithic (literally "Old Stone" Age). The Oldowan and Acheulian tool traditions of the first humans were the simplest technologies. As a result, they are lumped together into the **Lower Paleolithic** stage of cultural development. *Homo heidelbergensis* continued to make tools mostly in the Acheulian tradition. However, by 100,000 years ago or somewhat earlier, Neandertal and some other late archaic humans achieved a major leap forward in tool making with the development of the **Mousterian tool tradition** (named for the site of le Moustier in France). This new technology was revolutionary enough to warrant being considered a distinct Paleolithic phase--the **Middle Paleolithic**. Mousterian-like tool industries were employed at that time also by early modern *Homo sapiens* in some areas of Africa and Southwest Asia.



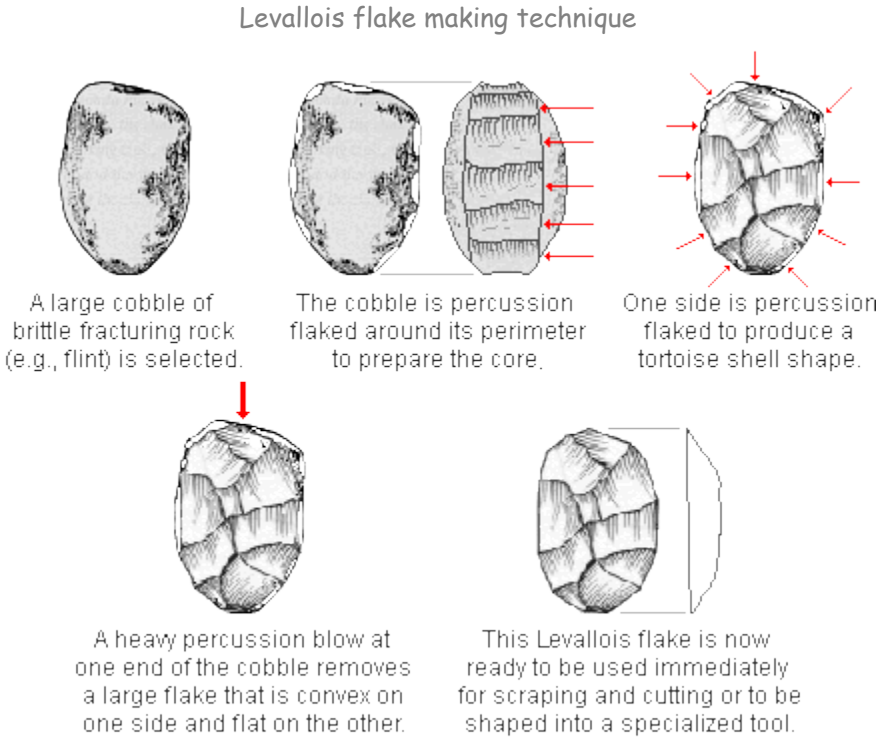
Note: the Paleolithic stages began earlier and/or persisted longer in different regions. Subsequently, the demarcations between stages was not sharp. The same is true of the transitions between hominin species.

Middle Paleolithic Technology

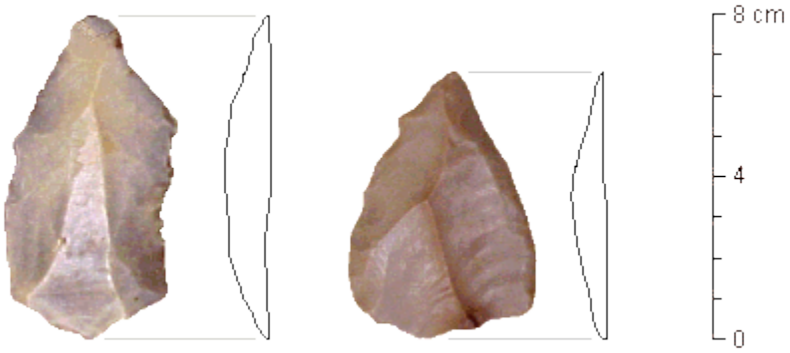
Neandertal man making a Mousterian hand ax

Throughout these progressive changes in tool making technologies, there was a growing sophistication in dealing with the environment, especially in connection with obtaining food. By the Middle Paleolithic, not all sites had the same tool kits. Specialized local tasks had resulted in tool variations among the Neandertals and their contemporaries. Much of this variation was developed within the Mousterian tool making tradition. This new technology was part of their successful adaptation to hunting and gathering, especially in subarctic and temperate environments of Europe during the last ice age which began about 75,000 years ago.

The Mousterian Tradition was marked by the progressive reduction in the use of large core tools, such as hand axes, as specialized flake tools became more common. Flakes of more or less standardized shapes and sizes were often made with the **Levallois prepared core technique**. Blocks or cobbles of flint and other brittle fracturing rock were percussion flaked on one side until a convex "tortoise shell" shape was formed. Then, a heavy percussion blow at one end of the core removed a large flake that was convex on one side and relatively flat on the other--i.e., a **Levallois flake**. This technique was first used by archaic humans around 250,000 years ago. It was perfected in the Mousterian Tradition by the Neandertals and some of their contemporaries.



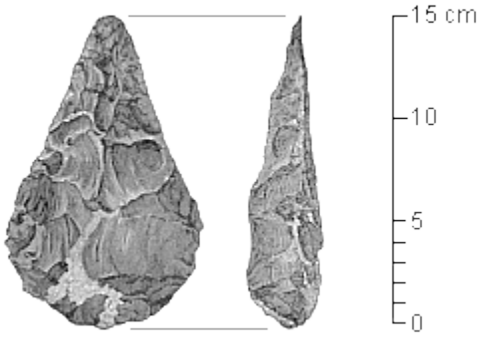
Levallois flakes were preforms for making a variety of scraping, cutting, and puncturing implements. The raw flakes were modified for particular uses by systematic percussion flaking their edges. Mousterian flake knives made in this way were apparently used for such tasks as cutting small pieces of wood and butchering animals. Flake scrapers were apparently used especially to process animal skins. Levallois flakes were also shaped into crude unifacial spear points by Neandertals. This was the first time in human prehistory that stone tips were affixed to spears. It allowed greater penetration of the spears and, subsequently, more effective killing of large animals. The fact that Neandertals were the pioneers in creating these new deadly weapons is further reason to reject the old view that they were "dull-witted, brutish, ape-like creatures."



Mousterian tradition unifacial hide scraper (left) and spear point (right)
(both were made from Levallois flakes)

Biface core tools, such as hand axes, continued to be made in the Mousterian tradition. However, they were much more carefully and extensively worked than in the Acheulian tradition. Small flake

scars on many of the Mousterian hand axes suggest that the craftsmen were using hammers of bone, antler, or similar relatively soft materials for better control in the final stages of shaping.

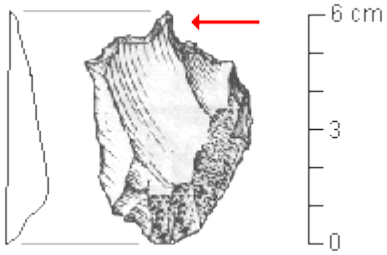


Mousterian tradition hand ax

Few wooden artifacts have been found associated with Neandertal remains. Those that have been discovered include what seem to be spears, plates, and possibly pegs. It is likely that Neandertals made other kinds of artifacts out of wood and more perishable materials. Their hand axes and some other stone tools very likely were used to create and modify artifacts out of these organic materials.

Other Evidence of Neandertal Culture

Much can be inferred about Neandertal culture from the archaeological evidence. For instance, it is probable that in colder climates they wore some sort of **protective clothing** to keep warm. In all likelihood, they used animal skins for this purpose. There are two sources of indirect evidence for this. First, many Neandertal sites have stone awls or borers. These were flakes that had been shaped to produce a beak-like projection on one end or side. Awls are usually used to punch or drill holes in relatively soft materials such as wood and leather. The second source of evidence is anatomical. A Neandertal skull from the French site of La Ferrassie has a peculiar wear pattern on its incisor teeth. This same pattern was typical of older *Inuit* (or Eskimo) women in the subarctic of North America during the 19th and early 20th centuries. In their case, it usually resulted from a lifetime of chewing their husband's boots every morning to soften them. It is likely that the La Ferrassie Neandertal also was softening leather in this manner. If Neandertals were making leather clothing of some sort, there is no evidence of what it might have looked like. The working of skins could also have been connected with making tents of some sort.



Neandertal stone awl

Another interesting piece of evidence has been uncovered recently that narrows the cultural distance between Neandertals and us. At the Divje Babe 1 site in Slovenia, a Neandertal artifact

was found that may be a four holed flute made from a bear leg bone. Since it dates to between 82,000 and 43,000 years ago, it is the earliest known musical instrument.

Subsistence Patterns

The Neandertals and other late archaic human populations were primarily hunters and gatherers who exploited a wide range of food sources. This very likely required them to seasonally migrate over vast territories.

Neandertal habitation sites usually contain large quantities of bones of many different kinds of animals, including those of big game. There has been a question as to whether the Neandertals had only scavenged dead bodies or actually hunted. That question has recently been resolved by the discovery of one of their spear points lodged in the neck bones of an ass at a 50,000 year old site in Syria named Umm el Tlel. Neandertals were unquestionably hunters, but their skills and technology apparently were less efficient than those of the modern *Homo sapiens* who replaced them in Europe and Southwest Asia.

No doubt, Neandertals gathered wild plants for food, to make tools, and probably medicine. Fifty stone tools from two Neandertal sites in southern Ukraine (Buran Kaya III and Starosele) have been found to have microscopic residues of wood, starch, and other organic substances. The residues on the bases of scrapers and combination spear-point/knives indicate that they were hafted on wood handles 80,000-32,000 years ago. Residues on the working edges and sharp tips of these tools show that they were used to process both plants and animals, including waterfowl. At two cave sites in Gibraltar (Vanguard and Gotham's Caves) there is strong evidence that 28,000 years ago Neandertals exploited marine food sources including mollusks, seals, dolphins, and fish. In addition, they butchered large land animals including wild pigs, red deer, and ibex. All of this evidence is important because it shows that Neandertals were more capable and flexible in tool making and food acquisition than had generally been thought.

There is circumstantial evidence that some Neandertals also obtained food at times by **cannibalism**. At Moula-Guercy Cave in France, 120,000-100,000 year-old human bones from 6 skeletons show clear evidence of meat and marrow removal in the same way that Neandertals processed game animal carcasses. Human cannibalism may have much greater antiquity than this. Tim White of the University of California at Berkeley believes that there is possible cannibalism evidence at an 800,000 year old site in Spain.

It would be a mistake to assume that human flesh was a major food source for Neandertals or other archaic humans. Cannibalism is not an efficient basis for subsistence because of the infrequency of human reproduction and our slow maturation rate. It does not make economic sense to exploit people as a primary food source. Cannibalism was probably more of an opportunistic activity for Neandertals and other archaic humans.

Most well known examples of cannibalism recorded by anthropologists and historians have been primarily for ritual purposes. Among many of the indigenous cultures of New Guinea and the Amazon Basin of South America, it was a normal funerary practice--the people consumed were dead

relatives. Why Neandertals occasionally ate people remains unknown, but there is one additional intriguing piece of evidence related to this question. At Mt. Cerceo Cave in Italy, a 57,000 year old severed Neandertal head had its base bashed in, possibly to gain access to the brains. Apparently later, the hole was enlarged and the jagged edges smoothed by abrasion so that the skull could have been used as a bowl.

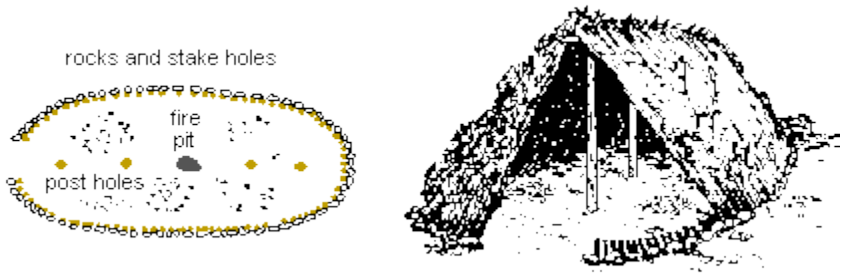
Fire Use

The earliest convincing evidence of fire use for cooking appears at the 550,000-300,000 year old late *Homo erectus* site at **Zhoukoudian** near Beijing, China and the 400,000 year old presumed archaic human site of **Terra Amata** near Nice on the French Mediterranean coast. In both cases the evidence is primarily in the form of food refuse bones that were apparently charred during cooking. In addition, there is possible evidence of simple fire hearths at Terra Amata. Unfortunately, there still is not sufficient evidence at either site to say conclusively that there was controlled fire in the sense of being able to create it at will. However, by 100,000 years ago, there is abundant evidence of regular fire use at Neandertal sites. By that time, they evidently were able to create fires when they wished to, and they used them for multiple purposes.

Harnessing fire would have given Neandertals and other archaic humans distinct advantages. It would have provided significant protection from cold winter weather in temperate and subarctic regions. It would have helped keep predators away from camp sites at night. Cooking would have helped breakdown cellulose in plant foods which would have made them more digestible. Cooking meat would have helped kill microbial parasites that wild animals often harbor. Fire probably also would have been a focal point for social gatherings.

Shelter

In temperate regions, the dwelling sites of early archaic humans apparently were often under cliff overhangs or in the open where they created simple brush covered dwellings. Examples of the latter have been found at the Terra Amata site. Excavation there in 1966 revealed evidence of what might have been 21 separate oval living floors within branch and brush huts on the beach. These structures apparently were up to 40 feet (12 m.) long and 20 feet (6 m.) wide. While some of the evidence of structures at Terra Amata is now in question, it is clear that people were living seasonally at that site, creating fires, cooking meat, and making tools.



Reconstruction of a 400,000 year old possible temporary dwelling at Terra Amata, France

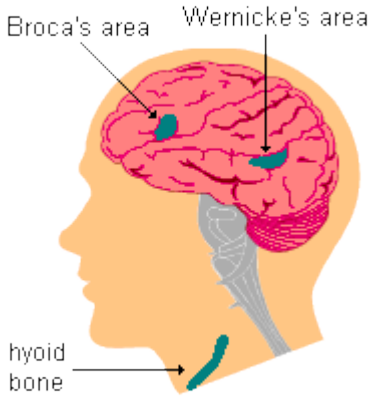
(illustration on the left is a view looking down at the ground without the structure)

There is abundant evidence that Neandertals regularly occupied the mouths of caves and rockshelters in Europe and Southwest Asia. These provided a degree of weather protection, especially during the colder times of the last ice age. It is also likely that they created open-air camps with temporary shelters during seasonal migrations to find food. It is unlikely that Neandertals often ventured deep into large caves since those areas are extremely dark, dangerous, and lack food as well as wood for fuel. However, some Neandertals did leave artifacts hundreds of feet into Bruniquel Cave in Southern France 47,600 years ago. Concentrated smoke residues high on the walls of that cave suggest that Neandertals were using torches for light.

Ritual Burial of the Dead

At the early archaic human site of Atapuerca in Spain, there is evidence of the intentional storing of bones from at least 32 people in a cave chamber by as early as 300,000 years ago. This behavior suggests a belief that dead humans are not the same as other animals. By 90,000 years ago, several Neandertal cave sites provide the first reasonably good evidence of **ritual burial of their dead**. They presumably buried relatives and friends in shallow graves dug into the soft midden soil of their living areas at the mouths of caves and rockshelters. Usually the bodies were flexed in a fetal position. Frequently, the bones were stained with **hematite**, a rust-red iron ore. It is likely that the bodies were either sprinkled with hematite powder or the powdered pigment was mixed with a liquid medium, such as vegetable seed oil, and painted on the bodies. In nearly half of the 33 known Neandertal burials, stone tools and/or animal bones were found in the graves. Not all paleoanthropologists agree that these objects were intentionally placed there in funerary rites. If they were, however, it implies that the Neandertals were trying to prepare the dead for what was ahead of them. In the case of a burial in Shanidar Cave, Northern Iraq, there may have even more elaborate ritual activity. Apparently, the body of a man had been placed on pine boughs in the grave and flowers from 8 different species had been sprinkled on top. It is difficult to account for such activity by Neandertals unless it is assumed that they believed in some sort of **afterlife**. If they thought that their dead relatives and friends were only food or garbage, it is highly unlikely that they would have carefully buried them in this way.

Neandertals also buried the heads of cave bears in at least two caves in Western Europe. At 12 feet tall standing upright, these now extinct animals were larger than any bear species today. These paramount carnivores evidently hunted the same animals that the Neandertals did, and they probably would have considered people to be food as well. Cave bears no doubt engendered considerable fear and respect as powerful, dangerous creatures. Therefore, it is not surprising that at Regourdou Cave in Southern France, the Neandertals dug a rectangular pit, lined it with stones, and buried at least 20 hematite covered cave bear skulls. The cache was intentionally capped with a large stone slab. A similar cave bear head burial pattern was found at Drachenloch Cave in Switzerland.



Anatomical features related to speech

Language Capability

The Neandertal ritual burial of their own dead implies a belief in an afterlife. This is basically a rudimentary religious concept. Likewise, the ritual burial of cave bear trophy heads is consistent with a supernatural belief system. The transmission of such beliefs from generation to generation very likely required a spoken language. Similarly, their tool making skills and other technical knowledge would suggest some sort of sophisticated communication.

Since the Neandertal brains had speech centers (Broca's and Wernicke's areas) that were as large as our own, it is reasonable to assume that they were capable of language. The modern human form of the FOXP2 gene has been found recently in the bones of two Neandertals from Northern Spain. This gene is associated with the ability to comprehend grammar and to control the mouth movements necessary to produce words. The implication is that Neandertals could comprehend and produce something like modern speech. The shape and position of the hyoid bone in the neck of Neandertals was essentially the same as in modern humans. This has important implications for speech because the horseshoe-shaped hyoid bone supports muscles in the jaw, tongue, and larynx. Its high location makes it possible to produce the extraordinarily wide range of human vocal sounds. However, since Neandertal mouths and nasal cavities were somewhat different in shape from our own, there is a question as to whether they would have been able to produce all of the vowels and consonants that we use today. Based on this chain of evidence, the current consensus among paleoanthropologists is that the Neandertals probably did have spoken language, though it may have sounded a bit odd to our ears.

NOTE: modern and relatively modern humans, such as Neandertals, are the only primates known to have their hyoid bone high in the neck. While this helps us produce a far wider range of vocal sounds, it also allows us to more readily choke on food and suffocate because it allows the entrances to both the trachea and the esophagus to be open at the same time. The fact that

nature selected for this potentially disadvantageous trait suggests that the evolutionary advantage of speech was very important.

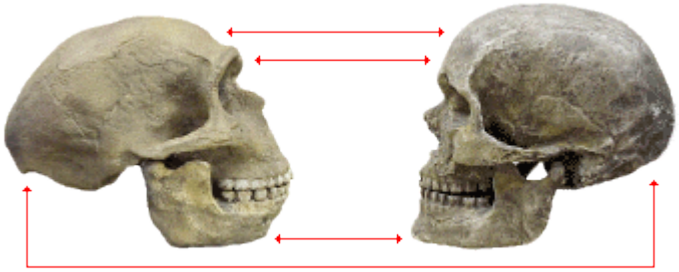
Social Support Networks

It is now becoming clear that the Neandertals had cultures and social organizations developed to the point that community members unable to provide for themselves were fed and cared for. The La Chapelle-aux-Saints man lived to well beyond the normal life expectancy of 30-35. He was 40-50 years old and had severe crippling arthritis that would have made walking difficult. In addition, he would have been limited to soft foods because he only had 2 remaining teeth. It is likely that his last years were made possible only because others provided food and protection for him. The same pattern of group support for those unable to take care of themselves was found at Shanidar Cave. The man who had been so carefully buried there in a ritual manner had major orthopedic problems. Crushing injuries earlier in life resulted in multiple broken bones. This apparently caused degenerative joint disease, the withering of one of his arms, and blindness in one eye. Like the La Chapelle-aux-Saints man, he would have been severely handicapped, yet he lived 30-45 years. To do this, he must have had considerable family and community support.

Early Modern Homo sapiens

All people today are classified as *Homo sapiens sapiens*--i.e., the *sapiens* variety of the species *Homo sapiens*. The first began to appear nearly 200,000 years ago in association with technologies not unlike those of the early Neandertals. It is now clear that they did not come after the Neandertals but were their contemporaries. However, it is likely that both modern humans and Neandertals descended from *Homo heidelbergensis*.

Compared to the Neandertals and other late archaic humans, modern humans generally have more delicate skeletons. Their skulls are more rounded and their brow ridges generally protrude much less. They rarely have the occipital buns found on the back of Neandertal skulls. They also have relatively high foreheads and pointed chins.



Neandertal modern *Homo sapiens*

The first fossils of early modern humans to be identified were found in 1868 in a 27,000-23,000 year old rock shelter site near the village of Les Eyzies in southwestern France. They were subsequently named the **Cro-Magnon** people. They were very similar in appearance to modern Europeans. Males were 5 feet 4 inches to 6 feet tall (1.6-1.8 m.) That was 4-12 inches (10-31 cm.) taller than Neandertals. Their skeletons and musculature generally were less massive than the Neandertals. The Cro-Magnon had broad, small faces with pointed chins and high foreheads. Their cranial capacities were up to 1590 cm^3, which is relatively large even for people today.

Origins of Modern Humans

Current data suggest that modern humans evolved from archaic humans primarily in East Africa. A 195,000 year old fossil from the Omo 1 site in Ethiopia shows the beginnings of the skull changes that we associate with modern people, including a rounded skull case and possibly a projecting chin. A 160,000 year old skull from the Herto site in the Middle Awash area of Ethiopia also seems to be at the early stages of this transition. It had the rounded skull case but retained the large brow ridges of archaic humans. Somewhat more advanced transitional forms have been found at Laetoli in Tanzania dating to about 120,000 years ago. By 115,000 years ago, early modern humans had expanded their range to South Africa and into Southwest Asia shortly after 100,000 years ago. Evidently, they did not appear elsewhere in the Old World until 60,000-40,000 years ago. This was during a short temperate period in the midst of the last ice age.

Important Early Modern Homo sapiens Sites

	Date of Fossil (years ago)
East Africa:	
Herto, Middle Awash	160,000-154,000
Omo 1	195,000
Laetoli	120,000
South Africa:	
Border Cave	115,000-90,000
Klasies River Mouth	90,000
Israel:	
Skhul and Qafzeh	92,000-90,000
Australia:	
Lake Mungo	60,000-46,000
Asia:	
Ordos (Mongolia)	40,000-20,000 ?
Liujiang (China)	139,000-111,000 ?
Zhoukoudian upper cave (China)	27,0000
Europe:	
Peştera cu Oase (Romania)	36,000-34,000
Combe Capelle (France)	35,000-30,000
Mladeč and Předmostí (Czech Republic)	35,000-25,000
Cro-Magnon (France)	27,000-23,000

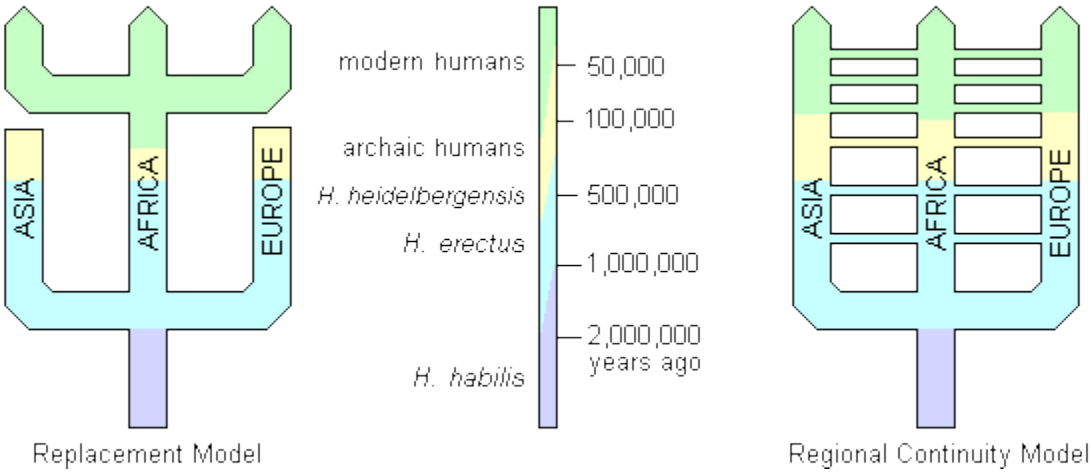
Note: Artifactual evidence indicates that modern humans were in Europe by at least 40,000 and possibly as
early as 46,000 years ago. Dating of the earliest modern human fossils in Asia is less secure, but it is likely
that they were present there by around 60,000 years ago.

It would seem from these dates that the location of initial modern *Homo sapiens* evolution and the direction of their dispersion from that area is obvious. That is not the case. Since the early 1980's, there have been two leading contradictory models that attempt to explain modern human evolution--the replacement model and the regional continuity model.

The **replacement model** of Christopher Stringer and Peter Andrews proposes that modern humans evolved from archaic humans 200,000-150,000 years ago only in Africa and then some of them migrated into the rest of the Old World replacing all of the Neandertals and other late archaic humans beginning around 60,000-40,000 years ago. If this interpretation of the fossil record is correct, all people today share a relatively modern African ancestry. All other lines of humans that

had descended from *Homo erectus* presumably became extinct. From this view, the regional anatomical differences that we see among humans today are recent developments--evolving mostly in the last 40,000 years. This hypothesis is also referred to as the "out of Africa", "Noah's ark" and "African replacement" model.

The **regional continuity** (or multiregional evolution) **model** advocated by Milford Wolpoff, of the University of Michigan, proposes that modern humans evolved more or less simultaneously in all major regions of the Old World from local archaic humans. For example, modern Chinese are seen as having evolved from Chinese archaic humans and ultimately from Chinese *Homo erectus*. This would mean that the Chinese and some other peoples in the Old World have great antiquity in place. Supporters of this model believe that the ultimate common ancestor of all modern people was an early *Homo erectus* in Africa who lived at least 1.8 million years ago. It is further suggested that since then there was sufficient gene flow between Europe, Africa, and Asia to prevent long-term reproductive isolation and the subsequent evolution of distinct regional species. It is argued that intermittent contact between people of these distant areas would have kept the human line a single species at any one time. However, regional varieties, or subspecies, of humans are expected to have existed.



Replacement Model

Regional Continuity Model

Replacement Model Arguments

There are two sources of evidence supporting the replacement model--the fossil record and DNA. So far, the earliest finds of modern *Homo sapiens* skeletons come from Africa. They date to at least nearly 200,000 years ago on that continent. They appear in Southwest Asia by at least 100,000 years ago and elsewhere in the Old World by 60,000-40,000 years ago. Unless modern human remains dating to 200,000 years ago or earlier are found in Europe or East Asia, it would seem that the replacement model better explains the fossil data for those regions. However, the DNA data supporting a replacement are more problematical.

Beginning in the 1980's, Rebecca Cann, at the University of California, argued that the geographic region in which modern people have lived the longest should have the greatest amount of genetic diversity today. Through comparisons of mitochondrial DNA sequences from living people

throughout the world, she concluded that Africa has the greatest genetic diversity and, therefore, must be the homeland of all modern humans. Assuming a specific, constant rate of mutation, she further concluded that the common ancestor of modern people was a woman living about 200,000 years ago in Africa. This supposed predecessor was dubbed "mitochondrial Eve". More recent genetic research at the University of Chicago and Yale University lends support to the replacement model. It has shown that variations in the DNA of the Y chromosome and chromosome 12 also have the greatest diversity among Africans today. John Relethford and other critics of the replacement model, have pointed out that Africa could have had the greatest diversity in DNA simply because there were more people living there during the last several hundred thousand years. This would leave open the possibility that Africa was not necessarily the only homeland of modern humans.

Critics of the genetic argument for the replacement model also point out that the rate of mutation used for the "molecular clock" is not necessarily constant, which makes the 200,000 year date for "mitochondrial Eve" unreliable. The rate of inheritable mutations for a species can vary due to a number of factors including generation time, the efficiency of DNA repair within cells, and varying amounts of natural environmental mutagens. In addition, some kinds of DNA molecules are known to be more subject to mutation than others, resulting in faster mutation rates. This seems to be the case with the Y chromosome in human males.

Further criticism of the genetic argument for the replacement model has come from geneticists at Oxford University. They found that the human betaglobin gene is widely distributed in Asia but not in Africa. Since this gene is thought to have originated more than 200,000 years ago, it undercuts the claim that an African population of modern *Homo sapiens* replaced East Asian archaic humans less than 60,000 years ago.

Regional Continuity Model Arguments

Fossil evidence also is used to support the regional continuity model. Its advocates claim that there has been a continuity of some anatomical traits from archaic humans to modern humans in Europe and Asia. In other words, the Asian and European physical characteristics have antiquity in these regions going back over 100,000 years. They point to the fact that many Europeans have relatively heavy brow ridges and a high angle of their noses reminiscent of Neandertals. Similarly, it is claimed that some Chinese facial characteristics can be seen in an Asian archaic human fossil from Jinniushan dating to 200,000 years ago. Like *Homo erectus*, East Asians today commonly have shovel-shaped incisors while Africans and Europeans rarely do. This supports the contention of direct genetic links between Asian *Homo erectus* and modern Asians. Alan Thorne of the Australian National University believes that Australian aborigines share key skeletal and dental traits with pre-modern people who inhabited Indonesia at least 100,000 years ago. The implication is that there was no replacement by modern humans from Africa 60,000-40,000 years ago. However, the evidence does not rule out gene flow from African populations to Europe and Asia at that time and before. David Frayer, of the University of Kansas, believes that a number of European fossils from the last 50,000 years have characteristics that are the result of archaic and modern humans interbreeding.

Assimilation Model

It is apparent that both the complete replacement and the regional continuity models have difficulty accounting for all of the fossil and genetic data. What has emerged is a new hypothesis known as the **assimilation** (or partial replacement) **model**. It takes a middle ground and incorporates both of the old models. Günter Bräuer, of the University of Hamburg in Germany, proposes that the first modern humans did evolve in Africa, but when they migrated into other regions they did not simply replace existing human populations. Rather, they interbred to a limited degree with late archaic humans resulting in hybrid populations. In Europe, for instance, the first modern humans appear in the archaeological record rather suddenly around 40,000 years ago. The abruptness of the appearance of these Cro-Magnon people could be explained by their migrating into the region from Africa via Southwest Asia. They apparently shared Europe with Neandertals for another 12,000 years. During this long time period, it is argued that interbreeding occurred and that the partially hybridized predominantly Cro-Magnon population ultimately became modern Europeans. In 2003, a discovery was made in a Romanian cave named Peştera cu Oase that supports this hypothesis. It was a partial skeleton of a 15-16 year old male *Homo sapiens* who lived about 30,000 years ago or a bit earlier. He had a mix of old and new anatomical features. The skull had characteristics of both modern and archaic humans. This could be explained as the result of interbreeding with Neandertals according to Erik Trinkaus of Washington University in St. Louis. Alan Templeton, also of Washington University, reported that a computer-based analysis of 10 different human DNA sequences indicates that there has been interbreeding between people living in Asia, Europe, and Africa for at least 600,000 years. This is consistent with the hypothesis that humans expanded again and again out of Africa and that these emigrants interbred with existing populations in Asia and Europe. It is also possible that migrations were not only in one direction--people could have migrated into Africa as well. If interbreeding occurred, it may have been a rare event. This is supported by the fact that most skeletons of Neandertals and Cro-Magnon people do not show hybrid characteristics.

Expansion Out of the Old World

The global population of modern *Homo sapiens* began to grow rapidly around 50,000-40,000 years ago. It was around that time they began to migrate into regions not previously occupied by people. Their movement into far northern areas coincided with the end of a long cold period during the last major ice age that had begun about 75,000 years ago. Modern humans apparently moved into Australia for the first time between 60,000 and 46,000 years ago. Since Australia was not connected to Southeast Asia by land, it is probable that the first Australians arrived by simple boats or rafts. Around 35,000-30,000 years ago, human big game hunters moved into Northeastern Siberia. Some of them migrated into North America via the **Bering Plain** (or Beringia) 20,000-15,000 years ago or possibly somewhat earlier. That intercontinental land connection appeared between Siberia and Alaska as a result of sea levels dropping more than 300 feet during the final major cold period of the last ice age. Until that time, all human evolution had occurred in the Old World. The rate of human population growth has continued to accelerate since then. The current world population is over 6.6 billion and intercontinental migration and gene flow are at higher levels than ever before.

A consequence of human migrations into new regions of the world has been the extinction of many animal species indigenous to those areas. By 11,000 years ago, human hunters in the New World apparently had wiped out 135 species of mammals, including 3/4 of the larger ones. Most of these extinctions apparently occurred within a few hundred years. It is likely that the changing climate at the end of the last ice age was also a contributing factor. However, the same cannot be said for the animal extinctions that occurred following the arrival of aboriginal people in Australia and Polynesians in New Zealand. In both cases, humans were instrumental in wiping out easily hunted species. Large vulnerable marsupials were the main victims in Australia. Within 5,000 years following the arrival of humans, approximately 90% of the marsupial species larger than a domesticated cat had become extinct there. In New Zealand, it was mostly large flightless birds that were driven to extinction by hunters following their arrival in the 10th-13th centuries A.D.

It is sobering to realize that the rate of animal and plant extinction has once again accelerated dramatically. During the last century and a half, the explosion in our global human population and our rapid technological development has allowed us to move into and over-exploit most areas of our planet. That exploitation has usually involved cutting down forests, changing the courses of rivers, pushing wild animals and plants out of farm and urban areas, polluting wetlands with pesticides and other man-made chemicals, and industrial-scale hunting of large land animals, whales, and fish. During the early 19th century, there were at least 40,000,000 bison roaming the Great Plains of North America. By the end of that century, there were only a few hundred remaining. They had been hunted to near extinction with guns. The same fate came to the African elephant and rhinoceros during the 20th century. Likewise, commercial fishermen have depleted one species of fish after another during the last half century. Governments have had to step in to try to stem the tide of these human population effects on other species. However, they have been only marginally successful. The World Conservation Union conservatively estimates that 7,266 animal species and 8,323 plant and lichen species are now at risk of extinction primarily due to human caused habitat degradation. The endangered list includes 1/3 of all amphibian species, nearly 1/2 of the turtles and tortoises, 1/4 of the mammals, 1/5 of the sharks and rays, and 1/8 of the birds. This list does not include the many millions of species that are still unknown to science. It is likely that most of them will become extinct before they can be described and studied.

People Today

Are we genetically different from our *Homo sapiens* ancestors who lived 10-20,000 years ago? The answer is almost certainly yes. In fact, it is very likely that the rate of evolution for our species has continuously accelerated since the end of the last ice age, roughly 10,000 years ago. This is mostly due to the fact that our human population has explosively grown and moved into new kinds of environments, including cities, where we have been subject to new natural selection pressures. For instance, our larger and denser populations have made it far easier for contagious diseases, such as tuberculosis, small pox, and the plague, to rapidly spread through communities and wreak havoc. This has exerted strong selection for individuals who were fortunate to have immune systems that allowed them to survive. There also has been a marked change in diet for most people around the globe since the last ice age to one that is less varied and now predominantly vegetarian with a heavy dependence on foods made from cereal grains. It is likely that the human species has been able to adapt to these and other new environmental pressures because it has acquired a steadily greater

genetic diversity. A larger population naturally has more mutations adding variation to its gene pool simply because there are more people. This happens even if the mutation rate per person remains the same. However, the mutation rate may have actually increased because we have been exposed to new kinds of environmental pollution that can cause additional mutations.

It is not clear what all of the consequences of the environmental and behavioral changes for humans have been. However, it does appear that the average human body size has become somewhat shorter over the last 10,000 years, and we have acquired widespread immunity to the more severe effects of some diseases such as measles and influenza.

Finally, can we say what direction human evolution will take in the future? This is a fascinating question to consider but impossible to answer because of innumerable unknown factors. Though, it is certain that we will continue to evolve until we reach the point of extinction.

NEWS: In July 2008, David Caramelli et.al. reported on their analysis of DNA recovered from the bones of a 28,000 year old Cro-magnon skeleton excavated in Paglicci Cave, Italy. They concluded that the mitochondrial DNA from this individual was very similar to that of modern people and not like that of Neandertals (July 16, 2008 issue of PLos ONE).

Early Modern Human Culture

Early modern Homo sapiens in Africa and Southwest Asia 100,000 years ago made tools that were similar to those of the Neandertals and other late archaic humans. These were mostly simple Mousterian-like Levallois flake and core tools. However, by 90,000-75,000 years ago some modern humans began producing new kinds of artifacts that were revolutionary enough to warrant their being placed into a different Paleolithic stage--the **Upper Paleolithic**. This was the height of technical sophistication during the Old Stone Age. These innovative developments are most well known from European sites, but similar advances were occurring elsewhere in the Old World and later in the New World as well. Foreshadowing these new technologies were harpoon-like bone projectile points in use by at least 75,000 years ago in Central Africa. Ultimately, there were a number of different regional Upper Paleolithic tool traditions. The most sophisticated may have been the **Magdalenian** tradition of Western Europe. It began about 17,000 years ago and lasted until the end of the last ice age around 10,000 years ago.

Paleolithic Tool Traditions In Europe

Paleolithic Stage of Development	Beginning (years ago)	Cultural Tradition
Upper Paleolithic	17,000	Magdalenian
	21,000	Solutrean
	27,000	Gravettian
	33,000	Aurignacian/Chatelperronian
Middle Paleolithic	75,000+ ?	Mousterian
Lower Paleolithic	700,000+ ?	Acheulian

Note: the Acheulian Tradition began by at least 1.5 million years ago in Africa. It did not reach Europe until much later when the first humans arrived. The Mousterian Tradition very likely began in Africa around 150,000-100,000 years ago. The first upper paleolithic tool traditions probably evolved in Africa as well.

The various Upper Paleolithic tool traditions were successful cultural adaptations to diverse environments around the world. In temperate and subarctic regions of the northern hemisphere, **specialized big game hunting** was the most common subsistence strategy. However, even among the societies that focused their hunting efforts on reindeer, horses, and other large mammals, there was exploitation of vegetable foods, fish, and other small animals. Upper Paleolithic peoples, such as the **Cro-Magnon** of Europe, became progressively more efficient at acquiring food. Small game and plant food exploitation became increasingly important to them after 15,000 years ago. This was a necessity because their populations apparently were growing rapidly and the climate was changing as the ice began to melt near the end of the last ice age. This climate related change in subsistence pattern began even earlier in the Southwest Asia and other relatively warm and dry regions.

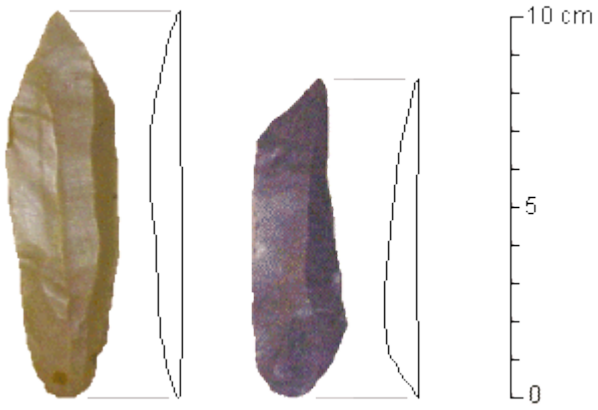
The Cro-Magnon people increased their food supply by developing **coordinated group hunting** techniques for the killing of large herd animals, especially in the river valleys of Western Europe and the plains of Central and Eastern Europe. They also developed new specialized hunting weapons. The art of spear hunting was revolutionized by the invention of the **spear thrower** (or atlatl) about 17,000-15,000 years ago. This was a wood or bone rod with a hook on one end that fit into a socket at the base of a spear. This device was used to push off spears. It increased the range and force of impact of projectiles by essentially increasing the length of the spear thrower's arm. The net effect was that hunters did not have to get as close to prey before throwing their spears. Toggle-head harpoons were invented about this time as well. The bow and arrow were invented by 12,000 years ago or a bit earlier. This further increased the range of projectiles. The fact that these weapon systems were developed toward the end of the last ice age is probably not a coincidence.

Spear thrower

Note: Spear throwers may have been made as early as 25,000 years ago in North Africa. Whether the European Cro-Magnon people independently invented this technology later or acquired it from North Africa is not known.

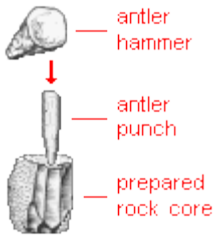
During the roughly 5,000 years of final glacial melt, large game animals became progressively scarce in the northern hemisphere. As a result, human hunting success would have been rarer. The combined effect of rapidly changing climates and increased hunting by humans heavily contributed to the extinction of at least 50 genera of large animals (mostly mammals) at that time. It also was in this late period after 15,000 years ago that fishing spears, hooks, and nets became increasingly more common. In Europe, the main focus of fishing appears to have been salmon going up streams to spawn and seals that were pursuing them.

The basis of many Upper Paleolithic stone tool forms was the **blade flake**. This is a thin, roughly parallel-sided flake that is at least twice as long as it is wide. The cross-section is usually either triangular or trapezoidal. They were made out of brittle-breaking rock materials such as flint, chert, and obsidian. Blade flakes were **preforms** for the manufacture of many different kinds of tools, such as knives, hide scrapers, spear tips, drills, awls, burins, etc.



European Upper Paleolithic tools made from blade flakes

Blade flakes were nearly standardized shapes that were struck off assembly line fashion from a prepared core usually by **punch flaking**. This method uses **indirect percussion** to better control the direction and force of the shock wave entering a core. This facilitated the repeated production of long, delicate flakes. Blades were struck off around a **prepared core** like the careful unwinding and sectioning of a roll of paper. It is possible to knock off blade flakes with direct percussion using a hammerstone rather than a punch, but it is more difficult.



Punch flaking

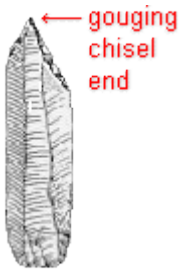
Tools made from blade flakes were far more efficient than core and flake tools made by earlier peoples when compared in terms of maximizing the use of precious brittle-flaking rock materials. This increased efficiency can be measured roughly in terms of the amount of cutting edge that can be produced from the same amount of stone.

Tool Tradition and Tool Category	**Length of Cutting Edge Per Pound of Stone** (approximate)	**Increase in Efficiency Over Previous Technology** (approximate)
Oldowan choppers (*Homo habilis*)	2 inches (5 cm.)	------
Acheulian hand axes (*Homo erectus*)	8 inches (20 cm.)	400%
Mousterian flake tools (Neandertal)	2 1/3 feet (100 cm.)	490%
Upper Paleolithic blade flake tools (modern humans)	10-39 feet (300-1200 cm.)	300-1200%

Sources: Watson, W. (1968) *Flint Implements: An Account of Stone Age Techniques and Cultures;* Hester, J. and J. Grady (1982) *Introduction to Archaeology.*

Upper Paleolithic tool makers also invented a further refinement in working with stone. After preliminary shaping by percussion flaking, they often finished a tool with **pressure flaking**. They literally pushed off the edge flakes with the tip of a deer antler in the final shaping and thinning process. This resulted in small, regular flake scars and much greater control in determining the shape of the final product. Pressure flaking was also used to retouch, or sharpen, thin edges of spear tips and knives.

During the Upper Paleolithic, we see the first abundant evidence of tools for making other tools. Such things as narrow gouging chisels, known as **burins**, were used to make and shape a host of other implements out of bone, antler, and ivory. Additional tools were created for the purpose of working on other implements such as pressure flakers, punches, and spear shaft straighteners. The Upper Paleolithic also saw a heavy dependence on **compound tools**, such as intentionally detachable harpoon points and interchangeable spear foreshafts of hard wood attached to spears. Compound tools have the advantage that they can be repaired. When one part breaks, it can be replaced rather than replacing the entire tool.



Burin made from a blade flake

Compound tools and tools designed to work on other implements are not just new kinds of tools but rather new kinds of tool-using principles. This was a giant intellectual leap forward. It also extended the range of raw materials that could be used for tool making. Bone and antler especially came into more common use. They had been used occasionally in the earlier Mousterian tool tradition, but were only modified clumsily by hammering, scraping, and burning. Among the Cro-Magnon people, bone and antler progressively replaced wood and stone for many functions. Bone and antler are more durable than wood and more flexible than stone so they do not break as easily and yet can be used to make relatively sharp cutting edges and penetrating projectile points. The amount of time that they are still usable can be extended by resharpening when they become dull. These materials were now being employed to make long thin knives, awls, sewing needles, clothing fasteners, harpoons with barbs, and many other useful implements. One result was that tailored clothing and tents were easier to make. The first known sewing needle came from southwestern France and dates to about 25,000 years ago. Residues of animal skin pants, shirts, and shoes have been found in a 22,000 year old Cro-Magnon grave near Moscow in Russia.


Bone sewing needle


Bone harpoon point with barbs

Upper Paleolithic "Art"

The Cro-Magnon people of Europe regularly decorated their tools and sculpted small pieces of stone, bone, antler, and ivory. Necklaces, bracelets, and decorative pendants were made of bones, teeth, and shells. Cave walls were often painted with naturalistic scenes of animals. Clay was also modeled occasionally. From our culture's perspective, these symbolic and naturalistic representations would be referred to as art. However, that is an ethnocentric projection. For the Cro-Magnon who made this art, it was very likely thought of as being something different, or at least much more, than we think of as art. For instance, it may have had magical and/or religious functions.

Upper Paleolithic European representational art began by at least 32,000 years ago and became intense 15,000-10,000 years ago. Perhaps, the most prominent portable art was in the form that has become known as **Venus figurines**. These are sculptures of women. They are not portraits but rather faceless idealized representations of well fed, healthy, usually pregnant nude women with

exceptionally large buttocks and breasts. Because of these exaggerated sexual characteristics, they are thought by most paleoanthropologists to be ritual objects symbolizing female fertility. Many of these stylized carvings are reminiscent of modern abstract art. Venus figurines were made from 27,000 years ago down to the end of the last ice age 10,000 years ago. They have been found from Western Europe all of the way to Siberia. Most were small enough in size to be easily hand held. The Venus of Laussel shown below on the right is a rare exception.

Venus of Willendorf
Austria
4 3/8 inches (11.1 cm.) tall

Venus of Lespugue
France
5 3/4 inches (14.6 cm.) tall

Venus of Laussel
France
17 inches (43.2 cm.) tall

Not all of the portable art was in the form of Venus figurines. Many small carvings have been found that depict animals and people, including men.

Carved bear teeth (from Duruthy Cave, France)

The Cro-Magnon people are, perhaps, most well known for their paintings on the walls of caves. Although, this cave art is most abundant in southwest France and northern Spain, it was made elsewhere by other early modern humans as well. With cave art, we see the first large scale, concrete symbols of human thoughts, feelings, and perhaps even beliefs about the supernatural. Over 150 Western European caves have been found with these ice age paintings on their walls.

Cave art from Lascaux, France (left and right) and Altamira, Spain (center)

Most of this cave art was made deep inside caves, in hard to get to dark areas. It is assumed that because of the locations, these areas were very likely sacred and that the art was inspired by

concerns with the supernatural. The majority of the figures are realistic looking herd animals, many of which are shown either wounded or pregnant. A number of paleoanthropologists have suggested that the artists were most likely performing sympathetic (or imitative) hunting and fertility magic. This would have been particularly important when this art was at its peak in sophistication (15,000-10,000 years ago) since at that time the last ice age was winding down and the herds of game animals were dying out or moving away to the north. Some of the animals depicted in the caves were predators, such as cave bears and lions, rather than prey. Drawing and painting them may have been a way of obtaining protection from these dangerous creatures or even a way of taking on their ferociousness and skill to increase human hunting success.

Human representations are rare among European cave paintings. Those that do exist usually are simple stick figures of men hunting. They often are shown with erect penises (as shown in the photo below). There are also several depictions of bearded adult male heads. One is life size. The largest is 6 1/2 feet (2 m.) tall with a cap. There have also been found geometric patterns in some of the caves that have been interpreted as female genitalia.

Painted human stick figure in Lascaux Cave (France)

Note the spear through the bison and its intestines hanging out. Two spear throwers are also shown next to the recumbent man who presumably has been gored and is dead, despite his erect penis.

Some of the European cave art seems to have been associated with ceremonies. These ceremonies may have been accompanied by music. The areas of the caves in which paintings were made and used often have good acoustical qualities. Drum sticks, flutes, and bull-roarers were found near the paintings in Lascaux Cave. The art very likely reflects the Cro-Magnon world view. Some researchers have suggested that they were, in part, depicting their spirit world. The fact that footprints of both adults and children have been found in some of the caves near the paintings has also suggested that the art was connected with initiation ceremonies.

Bull-roarer replica
14 inches (35.6 cm.) long

Some cave walls and bone artifacts have sequences of incised marks or ticks that strike one as being strictly utilitarian. They look like tallies. Such marks appear on bone artifacts made by late Neandertals, but they did not become common until the Cro-Magnon people developed their Upper

Paleolithic tool traditions. A few Cro-Magnon bone artifacts dating to as early as 25,000 years ago have what appear to be carefully incised lineal sequences of circular to crescent-shaped ticks. Alexander Marshack believes that at least one of these bones was made to be used as a lunar calendar of sorts.

Antler bone plaque incised with possible Cro-Magnon lunar calendar from southwest France

$4\frac{1}{4}$ inches (10.8 cm.) long

If calendars were being made, it implies that some people were recognizing the cyclical nature of the seasons. To people dependent on seasonally available foods and migrating herds, a calendar would have allowed more accurate predictions that would make the food quest more efficient. Also of great value to Upper Paleolithic hunters and gatherers would have been maps. The earliest possible map was scratched into a 16,000 year old bone found at Mezhirich in Ukraine. It evidently shows the countryside around a Cro-Magnon settlement.

The Cro-Magnon art changed through time. In the period 35,000-25,000 years ago, personal decorative ornaments such as bracelets, pendants, flutes, and figurines began to appear. The first Venus figurines were made about 27,000 years ago. There may not have been any cave art during the early part of this period, though it is not certain. The oldest known consists of charcoal drawings of bison and rhinoceroses dating to 31,000 ± 1,300 years ago in the French cave of Grotte Chauvet.

The second period of Cro-Magnon art was 25,000-18,000 years ago. Cave art apparently became relatively common in southern France and northern Spain at that time; however, it mostly consisted of rough animal outlines, abstract forms, and genitals. This was a very cold phase of the last ice age. The Cro-Magnon people probably created these paintings while wintering over in the caves.

In the period 18,000-15,000 years ago, more elaborate animal depictions were being painted. Shading was now used to indicate muscles and hair. In addition, animals were depicted moving.

The greatest period of European cave art was 15,000-11,000 years ago. This phase coincided with the final melt of the last ice age. Large sanctuaries were created which had realistically colored bison, horses, deer, cattle, and other large animals. The cave art at this time was likely the product of a burst of ceremonial activities. Many tools were carved decoratively in that terminal period as well. Likewise, personal decoration made of bone, teeth, and shell was very common. This was the period of the most elaborate Venus figurines. The tradition of making these stylized female representations continued for about 17,000 years. As such, it represents a remarkably long lasting belief system. The duration is even more remarkable when considering that Islam has existed for only about 1400 years, Christianity for 2000 years, and Judaism (in its current form) for less than 2500 years.

It is important to remember that Europe was not the only part of the world in which early modern humans produced art. The earliest known possible art object was found in South Africa. It is a 77,000 year old nodule of hematite that has engraved geometrical designs. Depictions of animals were being painted in southern African rock shelters possibly as early as 28,000 years ago and beads made from ostrich shells were being made there by 38,000 years ago. Rock art also has considerable antiquity in Siberia and Australia.

Social Changes

The extraordinary advancements in Upper Paleolithic technology and art did not take place in a vacuum. They developed during a time of remarkable social changes. Those changes created the necessary environment for the cultural innovations to occur. The ultimate driving force was probably a combination of population growth, larger communities, more efficient subsistence patterns, and increased life spans. From the time of the earliest humans until around 50-40,000 years ago, the global human population experienced only very modest growth. People evidently lived in small hunting, gathering, and scavenging bands that rarely exceeded a few dozen individuals. Life expectancy was typically 30 years or less, often much less. Recent analysis by Rachel Caspari and Sang-Hee Lee of human teeth from Upper Paleolithic sites has shown that beginning around 30,000 years ago there was a sharp rise in the number of people who were over 30 years old. They were living significantly longer on average. Caspari and Lee calculated that there probably was a 4-fold increase in the number of grandparents, since generational times were likely to have been around 15 years. In most societies of the past, grandparents performed the valuable function of taking care of and educating grandchildren, thereby allowing their own adult children to become more involved in food acquisition and other activities. This could have been one of the major contributors to the creative explosion of culture in Upper Paleolithic societies. Childrearing grandparents perform the critical job of passing on their society's skills and cumulative knowledge to the young. This was most likely the case in Upper Paleolithic societies as well. Another consequence of increased longevity is that women have more reproductive years. As a result, an increase in family size and the growth of populations is almost inevitable. Caspari and Lee suggest that the rapid cultural evolution, evidenced by new technology and art during the Upper Paleolithic, largely was a consequence of these demographic transformations. Likewise, the Upper Paleolithic cultural developments no doubt contributed to increased longevity in turn, which fueled the population explosion.