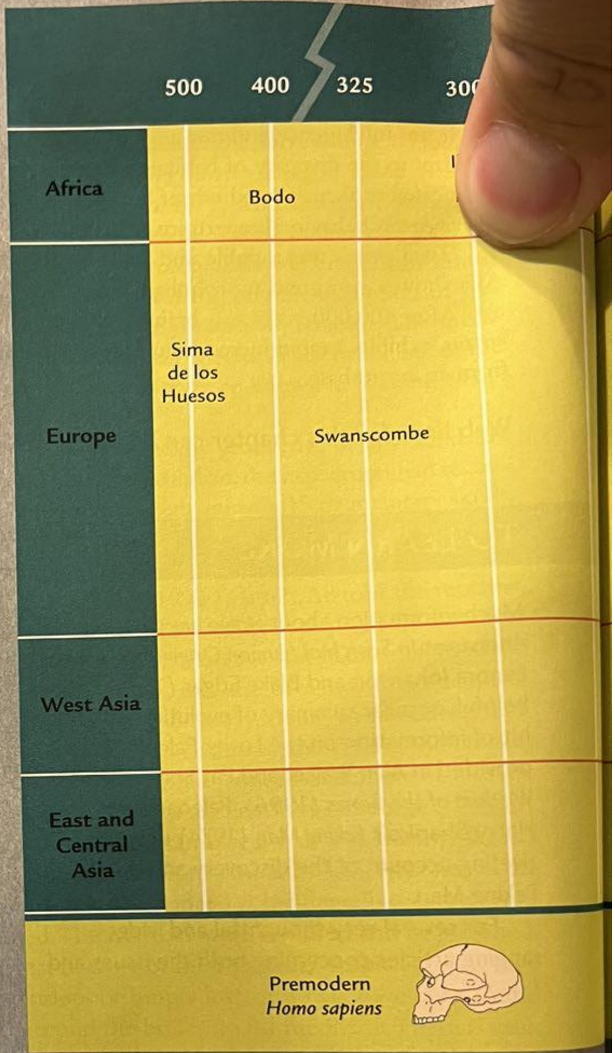
5

The First Humans

The Evolution of Homo sapiens

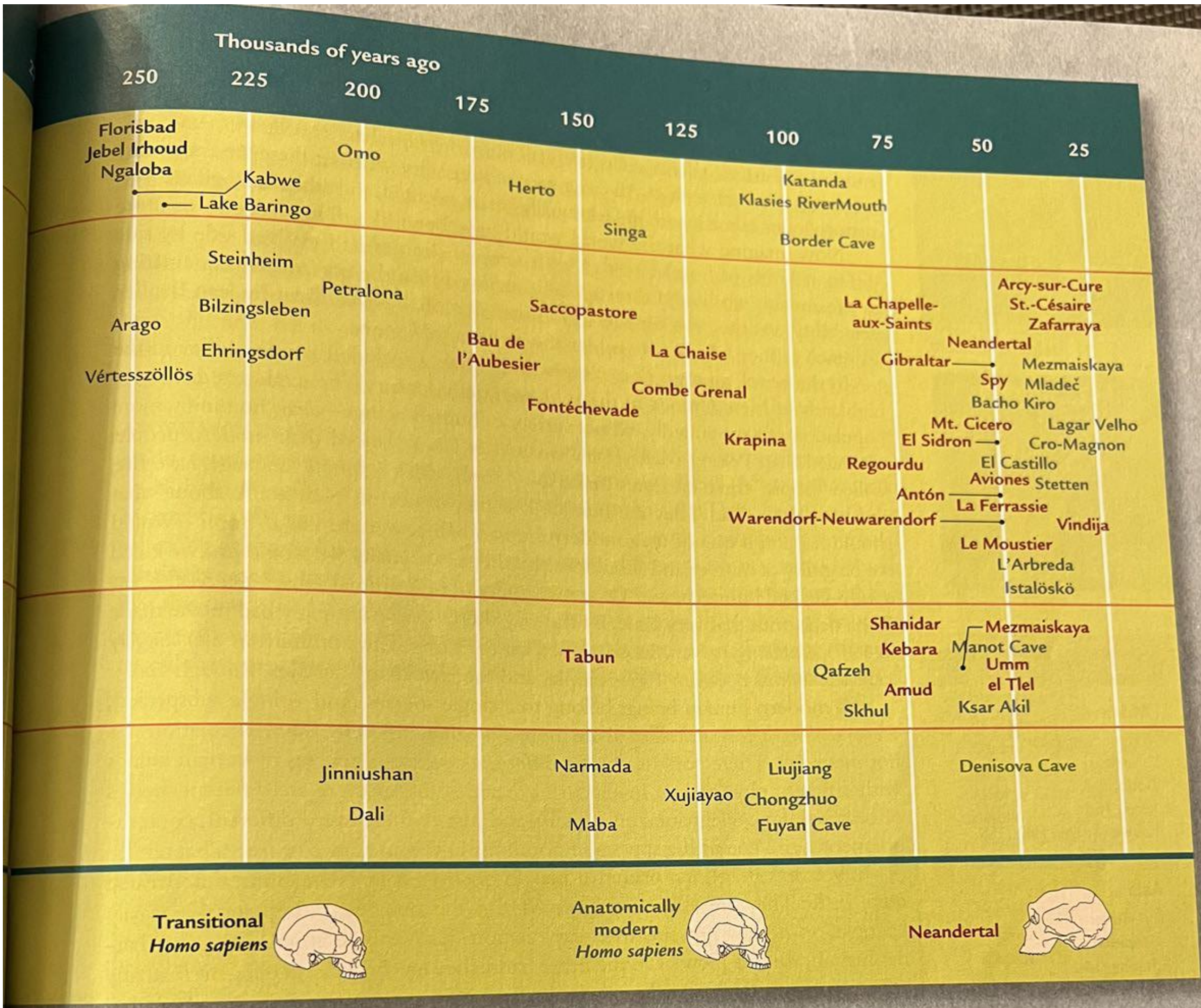


CHAPTER OVERVIEW

Beginning about 500,000 years ago, a great change is seen in the fossil hominin record. Brain size expanded, and the fossils look so much more modern they are categorized as *Homo sapiens*, though of a type classified as "archaic" or "premodern."

The best known of the archaic *Homo sapiens* are the Neandertals. Represented by the skeletons of hundreds of individuals and the mitochondrial DNA of a handful of them, the Neandertals seem to have developed alongside the ancestors of modern-looking human beings. They appear to have been physically highly specialized to life in the arctic cold of Pleistocene (Ice Age) Europe and West Asia. Neandertal bones reflect an enormous level of physical strength, in many cases beyond that seen in modern human beings. Ultimately, they may have been too specialized for cold and strength; the last of the Neandertals died out soon after 40,000 years ago.

Anatomically modern human beings appear in the fossil record sometime between 200,000 and 100,000 years ago. The question must be posed: "How did these first anatomically modern human beings arise?" Two competing models—the multiregional approach and the replacement hypothesis—have been proposed. In the multiregional model, modern human beings evolved from their archaic antecedents—the premodern humans discussed in this chapter—in various world areas more or less simultaneously. In the replacement model, modern humans evolved from a premodern variety just once, in one place—probably southern Africa—and spread out from there. In this



scenario, anatomically modern human beings replaced premodern humans wherever the two came in contact. A deductive test of the evidence using skeletal, artifactual, and genetic evidence is applied in this chapter. The result shows something more complicated than either simple model would predict.

PRELUDE

SCIENCE CONSISTENTLY HAS SHOWN THAT, THOUGH *individual* human beings may differ in terms of their athletic propensities, math and writing skills, or musical and artistic talents, collectively all human *groups* share equally in these physical and intellectual abilities. All categories of humanity, whether these are defined by nationality or ethnicity, are in fact equally smart, talented, and athletically gifted.

Now imagine what the world would have been like if, instead, two or more different kinds of human beings with *unequal* abilities had evolved side by side in the ancient world and then actually survived into the present. This fascinating possibility was the basis for the 1953 novel *You Shall Know Them*, by Jean Bruller, a French author who wrote under the pen name Vercors.

In the novel, a group of explorers investigates a secluded, pristine valley in the highlands of New Guinea in the mid-twentieth century. The explorers discover a population of a presumedly extinct variety of human beings—*living* hominins, more advanced than Peking Man (*Homo erectus*) yet less advanced than modern people. Called "tropis," these creatures make stone tools, speak a simple language, have fire, and bury their dead. They are human. But they're not us. Now think about what should happen if one of us, a modern human being, were to kill a "tropi?" Would we be guilty of murder and should we pay the same penalty we would had we killed a fully-fledged human being? Or are we guilty of only animal abuse? *You Shall Know Them* deals with that very issue. By the way, there was a stunningly bad movie made in 1970, *Skullduggery*, very loosely based on the book. The hominins in *Skullduggery* look like a cross between 1960s hippies and the Ewoks in Star Wars. Enough said.

All modern human beings belong to a single species (and a single subspecies), *Homo sapiens sapiens*, and all of us are more alike than different. But this situation was not inevitable. There could today be different, coexisting species of human beings with different physical and intellectual capacities, just as there are different species of bear, antelope, elephant, and camel—and just as there were different, contemporaneous, and coexisting species of hominins in the ancient past (see Chapter 3).

In Vercors's novel, the primitive people discovered in New Guinea are treated quite badly. They are essentially enslaved. On the one hand, they are not legally "people," so no law prevents their exploitation (just as there is no law against harnessing a horse to a plow). On the other hand, they are far more intelligent than any other nonhuman animal and can be trained to do things modern humans can do but find degrading, boring, or dangerous. Considering the amount of mistrust and hatred that exists today among the empirically minimally different individuals of our single species, it is frightening to consider what the world would be like if there were truly different, coexisting species of human beings. Remarkably, this nearly happened.

The Neandertals to be discussed in this chapter are an extinct variety of human beings that come chronologically closer to the modern era than do any other nonmodern hominin; they became extinct less than 40,000 years ago, a mere tick of the evolutionary clock. In fact, there was an overlap of thousands and in some regions maybe tens of thousands of years during the waning years of the Neandertals and the ascendance of the earliest anatomically modern humans (AMHs). As we will see later in this chapter, there even is strong genetic evidence that at least some AMH populations in Europe and Asia interbred with Neandertals, producing hybrid offspring.

The Neandertals were not only similar to us in many ways but also quite different. Though often depicted as apelike or subhuman, they managed to survive for tens of thousands of years during an extremely harsh period of the

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Pleistocene, or Ice Age. They did so through their great intelligence, inventing sophisticated stone tools for hunting, producing clothing and shelter, and using fire. Neandertals are also noted for another behavior that contradicts their modern stereotype: They buried their dead. In recognizing the enormity of death and in ceremonially disposing of the mortal remains of their comrades, they exhibited a behavior that shows their close kinship to us.

Despite this, Neandertals were surely quite different from us both in how they looked and, most likely, in their intellectual capabilities. Considering how badly we humans treat one another—and that we are more similar to one another in how we look and how we think than we would be to living Neandertals—the Neandertals probably would have ended up like the primitive hominins in Vercors's book, doomed by us to lives of confinement, drudgery, and pain (Gould 1988).

AS WE SAW IN CHAPTER 4, after about 1 million B.P., the tapestry of human evolution seems to have been characterized by a single primary thread (*Homo erectus*) made up of three generally similar strands in Africa, Asia, and Europe. Then, beginning as far back as 600,000 years ago, there was a burst of change, with new hominin varieties appearing on the evolutionary stage. Though regional differences are maintained among the fossils seen in Africa, Asia, and Europe, these hominins share in common the fact that they are morphologically more modern in appearance than previous hominin species, so much more modern in cranial capacity and shape, in fact, that some researchers call these new hominins **premodern,** or **archaic, *Homo sapiens*** (Figure 5.1).

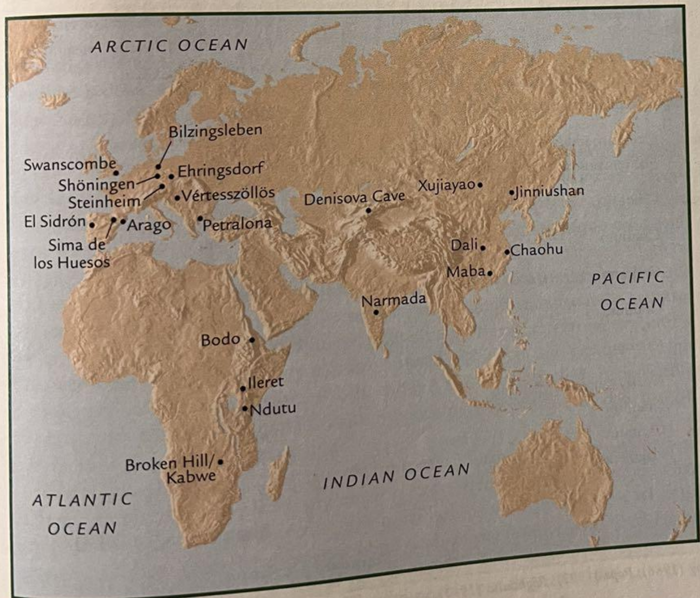

FIGURE 5.1
Fossil localities of premodern *Homo sapiens*.

Premodern *Homo Sapiens*: Extinct sub-species of humanity that share much in common with modern or anatomically modern *Homo sapiens*, but who commonly retain primitive skeletal features and possess a somewhat smaller mean cranial capacity than modern people.

CHRONICLE

CHAPTER SITES

Europe
(Neandertals)

These premodern humans shared a bigger, more modern brain than previous hominins had. The mean cranial capacity of the premoderns (excluding the Neandertals, who will be treated separately) was a little over 1,200 cc—more than 20% larger than that of their evolutionary antecedents and about 80% of the modern human mean of about 1,450 cc (see Table 5.1). Most of the premodern fossil specimens still possess large brow ridges. But more like the modern form, they also exhibit steeper foreheads, generally (though not universally) thinner cranial bones, and flatter faces than *erectus*.

TABLE 5.1 *Major Premodern* Homo sapiens *Fossils (Exclusive of the Neandertals) Discussed in Chapter 5*

COUNTRY	LOCALITY	FOSSILS	AGE (YEARS)	BRAIN SIZE (CC)
Germany	Steinheim	Cranium	200,000–240,000	1,200
	Bilzingsleben	Cranial fragments	228,000	
	Ehringsdorf	Cranial fragments	225,000	
	Mauer	Mandible	<450,000	
England	Swanscombe	Occipital cranium	225,000	1,325
Greece	Petralona	Cranium	160,000–240,000	1,400
France	Arago	Cranium and fragmentary remains of 7 individuals	250,000	1,200
Spain	Sima de los Huesos	15 crania	>430,000 >430,000 >430,000	Sima de Los Huesos: 15 crania, mean size 1232cc.
Hungary	Vértesszöllös	Occipital fragments	200,000	1,250
Zambia	Kabwe (Broken Hill)	Cranium, additional cranial and postcranial remains of several individuals	>125,000	1,280
Tanzania	Ndutu (Olduvai)	Cranium	200,000–400,000	1,100
Kenya	Ileret	Cranium	300,000	1,400
Ethiopia	Bodo	Cranium	200,000–400,000	
South Africa	Elandsfontein	Cranium		
India	Narmada	Cranium	150,000?	1,300
China	Jinniushan	Nearly complete skeleton	200,000	1,350
	Dali	Cranium	200,000	1,120
	Maba	Cranium	130,000–170,000	
	Xujiayao	Fragments of 11 individuals	100,000–125,000	
			Mean	1,261.43
			Standard Deviation	87.86

Data from Arsuaga et al. (1993); Day (1986); Pope (1992); Rightmire (1991).

PREMODERN HUMANS: FOSSIL EVIDENCE

Regrettably, in almost every case, the number of specimens of any given extinct hominin species currently in the hands of paleoanthropologists is extremely small. In many cases, in fact, the extant fossils are "one-offs," solitary examples representing a single human ancestor from a single site, and the precise relationship of these to the "one-offs" from other sites is very difficult to assess. As mentioned in Chapters 3 and 4, when the number of hominins belonging to a sample is small, it's extremely difficult to gauge the diversity within a species. And, in truth, when there's only a single specimen, it is impossible to measure that diversity. Clearly, even under the best circumstances, it is challenging and even problematic to know for sure if two similar but differing specimens from different sites are similar enough to belong to the same species or different enough to belong to separate species.

This challenge is particularly great when looking at fossils that date to the period between 500,000 and 100,000 years ago. Indeed, there are several extremely important, single specimens found at a number of sites in Europe and Asia, including Steinheim (Germany), Petralona (Greece), Arago (Italy), Dali (China), and Jinnuishan (China). They certainly share many anatomical features, but there's enough variability among them to make it difficult to know if they were members of the same species.

Rarely, however, paleoanthropologists get very lucky and find a large number (by paleoanthropological standards, anyway) of fossils together at the same site, dating to the same time period. This is the case for the cave called, appropriately enough, the Sima de los Huesos, the Cave of the Bones, in Spain. Here, José Luis Arsuaga and his colleagues (1993, 2014) have, since the early 1990s, recovered more than 6,500 bones and bone fragments belonging to 28 individuals of a single hominin species. Along with many of the bones of their postcranial skeletons (the bones below the head), the Sima de los Huesos assemblage includes 17 crania, some of them very well preserved (Figure 5.2).

The crania exhibit some variability, as you might expect in any population of individuals (Arsuaga et al. 2014). However, they all share essential features of form that show conclusively that they were members of the same species: they all have a continuous, large brow ridge that presents itself as a double arch (one over each eye orbit), a lower face that juts out (less than in an ape, but more than in a modern human being), and a large lower jaw, part of a massive **masticatory complex** (for chewing). Fifteen of the crania are preserved well enough to accurately measure the brain size of the Sima de los Huesos individuals. The mean cranial capacity is 1232 cc, about 85% of the modern human mean (1450 cc) and actually within the range of modern human brain sizes, though the configuration is decidedly different, with a smaller forebrain than in modern people. Finally, the date for the specimens is firm: 430,000 years ago.

In summary, the Sima de los Huesos hominins clearly are not representatives of *Homo erectus*; their crania simply are too large. If not *Homo erectus*, to what group do these 28 human ancestors belong? There is no consensus on what to formally call them (they have been dubbed both *Homo heidelbergensis* and *Homo neanderthalensis*), but most researchers recognize that these specimens represent a variety of premodern human beings. They're not us, but they are close.

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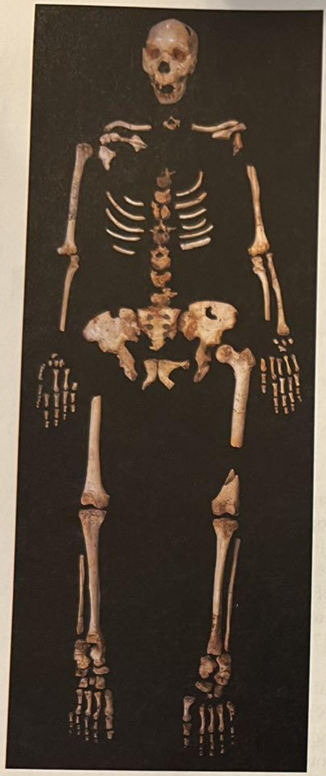

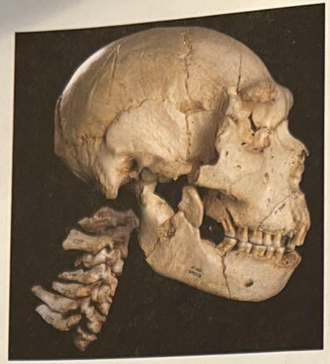

FIGURE 5.2
Cranium 5, one of the adult premodern human remains found at Sima de los Huesos in Spain (right). The image on the left is a rendering of a nearly complete skeleton cobbled together from the remains of several different adults found at the same site. *(Javier Trueba/ Madrid Scientific Films/ Science Source)*

PREMODERN HUMANS: CULTURAL EVIDENCE

When we begin replicating stone tools in my experimental archaeology course, it is the tendency of many students simply to grab hold of a couple of random rocks, placing one in each hand. Next, they close their eyes (behind the required safety goggles), wind up with their dominant hand, say a prayer (well, some do), and viciously smash down on the rock they were hoping to break. This approach isn't particularly effective and involves a level of serendipity and knuckle smashing that our ancient ancestors left behind more than 2.5 million years ago. Sure, using my students' initial approach, you may produce, by sheer luck and determination, some usable, sharp-edged flakes. But this is a wasteful strategy, and much of the good stone my students worked so hard to find and transport back to the lab ends up as battered, shattered chunks of useless rock. Stone toolmaking, as my students soon learn, is not a random but a highly controlled, well-thought-out process, designed to get the most sharp-edged flakes of a consistent size and shape as is possible from a stone nodule.

Levallois: Stone-tool technology involving the production of consistently shaped flakes from carefully prepared cores.

The **Levallois** stone-tool industry that typifies premodern *Homo sapiens* allows the toolmaker to accurately predict the shape and size of a flake about to be removed from a stone core. This new industry involved a shift in emphasis from the production of core tools to the production of flake tools. Instead of sculpting a single, large, multipurpose tool (like the handaxe) from a stone nodule and using only the waste flakes that fortuitously fit a given need, emphasis now shifted to the flakes themselves, whose form and size were controlled by careful preparation of the core (Figure 5.3). The stone nodule, or core, was no longer the object to be shaped into a tool but instead became the source from which flakes of given sizes and shapes were produced. The flakes were used as blanks to be refined into tools intended for specific tasks. The

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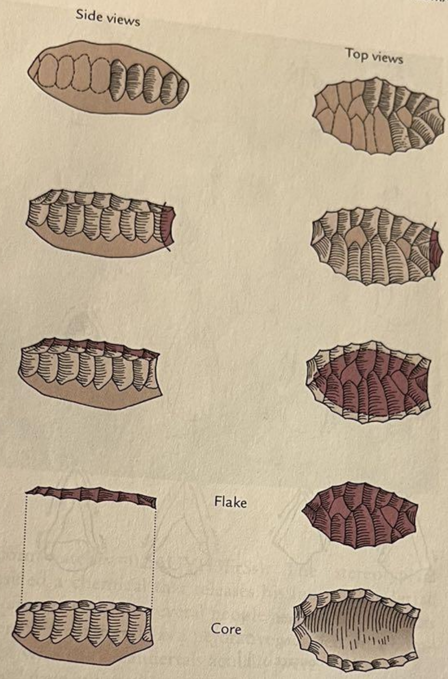


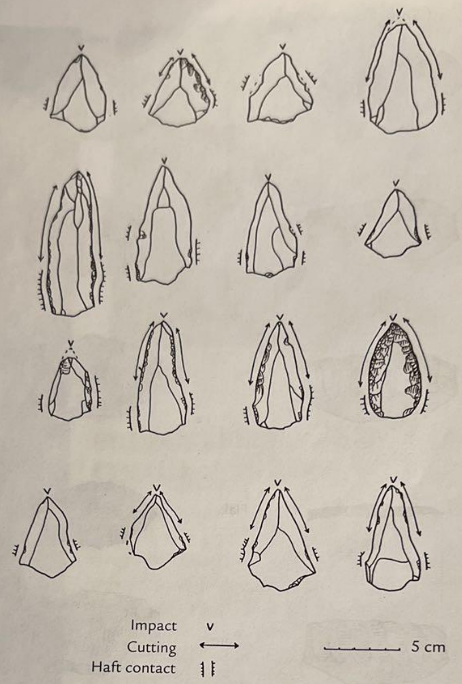
FIGURE 5.3
In Europe and west Asia, the archaic humans developed a toolmaking technology called Levallois in which a stone core was prepared so as to allow the production of flakes of a consistent size and form. The steps of Levallois core preparation and blade production are presented here. *(After J. Bordaz 1970)*

Levallois technique enabled flakes of predetermined and consistent size and form to be produced (Figure 5.4).

The Levallois technique involves this kind of careful preparation of the stone core for patterned and predictable flake removal. Preparing the core allowed premodern humans finer control of flake removal than had previously been possible. By precisely controlling the size and form of a flake, each finished tool could be more highly specialized for a particular task. The right shape for tools with functions like cutting, piercing, or perforating could be ensured. The technique was also far more efficient in its use of stone than either Oldowan or Acheulean. A greater amount of sharp, usable edge is produced per unit weight of core. A replicative study by Bruce Bradley (Gamble 1986) showed that four or five consistently shaped flakes could be removed from a single Levallois core.

It now appears that as long as 500,000 years ago in southern Africa, hominins were producing stone points which they likely hafted onto shafts for use in

FIGURE 5.4
Levallois flakes from sites in Israel. These triangular flakes may have been used as stone tips on wooden spear shafts. *(Courtesy of John Shea)*



hunting (Wilkens et al. 2012). The production of such multicomponent tools marks an enormous jump in toolmaking abilities by our ancestors.

THE NEANDERTALS

Neandertals are big dumb guys. They like professional wrestling. They're big fans of Johnny Knoxville. They drink beer for breakfast. They vote Republican (kidding). At least that's the stereotype. If someone calls you a Neandertal, it's not a compliment. Look at the earliest artistic reconstruction of a Neandertal published in 1909 in the French magazine *L'Illustration* (Figure 5.5). The image is a laughable caricature of a scary-looking, hairy ape-man. Neandertals have been the archetype of "cavemen" ever since: ugly, apelike, violent, brutish, and stupid (Hager 1994). I have just watched a laughably horrible movie made in 1953 called *The Neanderthal Man*

FIGURE 5.5
The first artist's conception of a Neandertal as it appeared in the popular press, first in the French magazine *L'Illustration* and soon thereafter in the *Illustrated London News* (March 6, 1909). (Illustrated London News, *March 6, 1909. Artist: Kupka*)

(https://www.youtube.com/watch?v=0ZAUYH3FrSs). The stereotypical mad scientist has synthesized a chemical that releases his inner Neandertal, whereupon he viciously attacks and kills several people and sexually assaults women. But using the term "Neandertal" as a pejorative is based on a complete misunderstanding of who the Neandertals actually were.

In reality the Neandertals* were just another group of premodern human beings. They happen to be better known because of a number of historical accidents. For example, they were abundant in Europe (Figure 5.6), and most early paleoanthropological research was undertaken there because most of the world's paleoanthropologists have come from Europe. Also, Neandertals used caves extensively, and archaeological remains are better preserved in cave settings.

The Neandertal name comes from the Neander Valley in Germany, where, in 1856, not the first such fossil was found but the one that first caught the attention of the scientific community (see Chapter 1; Figure 5.7). Though it was big, indicating a brain size at least as large as that of a modern human being, the

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*You will sometimes find *Neandertal* spelled *Neanderthal*. My stupid spell check insists on substituting my spelling, without the "h," to one with it. The original German spelling included an *h*, though it was (and is) pronounced as if no *h* were present. Modern German spelling has removed the *h*, so it is not used in this text. To complicate matters further, according to the rules of biological nomenclature, under most circumstances the original name given to a species cannot be changed. Because the Neandertals were originally given the species name *neanderthalensis*, with the silent *h*, we are obliged to leave the *h* when using the taxonomic name.

basis of the form of the skull, that the Neandertals were apelike, Boule's reconstruction showed a bent-over, splayed-toe, apelike creature. It probably didn't help that the specimen Boule chose to focus on had had a bad case of arthritis that may have caused the individual to bend over when walking.

FIGURE 5.7
The skullcap of the specimen that gave this group of archaic humans their name, discovered in the Neander Valley in Germany in 1856. *(Photo: Jürgen Vogel. LVR-LandesMuseum Bonn.)*

But who were the Neandertals, really? The evidence now is quite extensive that they were not club-toting caricatures. They were an intelligent, successful species with a sophisticated tool kit and mastery of fire. Evidence clearly suggests that they possessed an "interior" life that included art and, perhaps, ceremony and burial of their dead (Balter 2012a, 2013). They were a distinctive, now-extinct variety of premodern human beings, in some ways like us and in some ways very different (Figure 5.8). Some paleoanthropologists apply the taxonomic label *Homo sapiens neanderthalensis* to them, though others believe that they were sufficiently different from anatomically modern human beings that they are not directly ancestral to us and warrant a separate species classification, *Homo neanderthalensis.* Their roots in Europe can now be traced back to more than 400,000 years ago, an age equivalent to that of some of the other European premoderns listed in Table 5.1. However, true, or "classic," Neandertals possessing all the typical traits (to be discussed) were confined to Europe and west Asia and date from about 130,000 to 40,000 years ago.

Morphological Evidence

Though we recognize the Neandertals were related to modern humanity, controversy persists over their precise place in the human family: Were they our evolutionary grandparents or just distant cousins who followed a separate evolutionary pathway? (See Trinkaus 1983a, 1983b, 1986, 1989; Trinkaus and Shipman 1993; Wolpoff 1989b; and especially F. Smith 1991.)

CRANIAL MORPHOLOGY

The Neandertals were not tiny-brained cavemen. In fact, Neandertal brain size often surpassed that of modern human beings. Cranial capacities range from about 1,300 cc to more than 1,600 cc, with a mean of nearly 1,480 cc (see Table 5.2); modern human mean cranial capacity is about 1,450 cc.

FIGURE 5.6
Fossil localities of Neandertals and Denisovans.

shape was all wrong, with protruding, apelike bony ridges above the eyes, a face that projected forward like that of an ape, and a flattened profile rather than the rounded profile of a modern human skull.

Researchers of the time had difficulty explaining the Neandertal skull. (One scholar even suggested that its peculiar appearance was the result of "stupendous blows" with a heavy instrument sustained during the individual's lifetime.) However, as more Neandertal specimens—as all such similar fossils were labeled—were discovered in Europe, it became clear that the Neandertal skull form represented a distinct and extinct variety of humanity.

In the attempt to assess the precise relationship between the Neandertals and modern humans, a major error crept into the discussion. In 1913 French scientist Marcellin Boule produced a reconstruction of the entire Neandertal skeleton that was rife with error (Boule and Vallois 1923). Assuming, on the

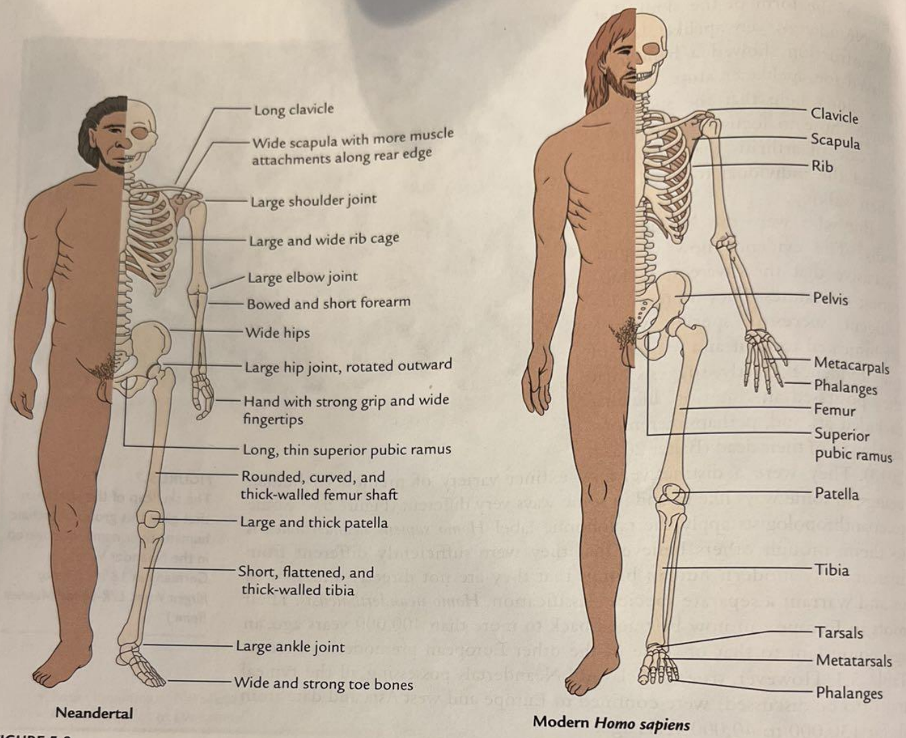


FIGURE 5.8
In this comparison of the skeletons of a modern human being and a Neandertal, the so-called musculoskeletal hypertrophy of the Neandertals when compared to modern humans is readily apparent. *(After Stringer and Gamble 1993)*

Though similar in size, the shape of the Neandertal cranium was different from ours. Viewed from the side, the modern human head presents a round profile while the Neandertal cranial profile is flatter. The configuration of the Neandertal brain, therefore, was different from ours, with less in the front and more to the rear. A recent investigation shows these differences developing in early childhood. Using a computed tomography (CT) scanner to trace brain expansion in human and chimp children during their years of development, researchers found a dramatic widening of the temporal lobes of the brain among humans but not chimps during the first year of life (Gunz et al. 2010). When the development of the Neandertal brain was compared to humans and chimps (by creating imprints called endocasts of Neandertal brains from four preserved crania), the researchers found no marked ballooning of the temporal lobe like that experienced during the development of modern human infants. This is significant, since the temporal lobe is important in our ability to create abstract representations of our surroundings.

FIGURE 5.9
These typical Neandertal skulls are from (left) Amud and (right) Tabun in Israel. *(Left, © Israel Antiquities Authority; right, © The Trustees of the Natural History Museum, London)*

FROM THE NECK DOWN: BUILT FOR COLD

Contrary to Boule's reconstruction, below the head the Neandertal skeleton is essentially modern in appearance but with some crucial differences. One morphological pattern is consistent with a physical adaptation to cold: Neandertals were relatively wide with broad, squat torsos and short extremities (see Figure 5.8; Ruff et al. 1993; Trinkaus 1983a), a body form associated in modern humans with cold environments because it retains heat better than does a body with a small torso and long limbs. Anthropologist Christopher Ruff (1993) compares the Neandertal body to that of a modern Inuit (Eskimo). This adaptation probably reflects the fact that the Neandertals flourished during a glacial maximum in Ice Age Europe.

This biological adaptation to life under cold conditions may explain how the Neandertals were able to survive as far north as just shy of the Arctic Circle in Russia more than 40,000 years ago (Slimak et al. 2011).

FROM THE NECK DOWN: BUILT FOR STRENGTH

Musculoskeletal Hypertrophy: Great size and associated strength in the muscles and bones of a species or individual.

In about every area on the skeleton where researchers have looked, the Neandertals exhibit what is called **musculoskeletal hypertrophy**. For example, the Neandertals were generally short and stocky when compared to modern humans, and the bones of their lower legs reflect this build (Gibbons 1996). The breadth of their scapulae (shoulder blades) and the length of their clavicles (collar bones), along with the robustness of areas of muscle attachment on those bones, are indicative of broad, powerful shoulders (Churchill and Trinkaus 1990).

The great size and robustness of their upper arm bones (Ben-Itzhak, Smith, and Bloom 1988) and the large areas for muscle attachment on their forearms (Trinkaus 1983a) are clear indications that the Neandertals had tremendous upper-body strength. Also, in their ribs and vertebrae Neandertal bones show areas for muscle attachment far larger than what is seen in modern humans.

Researcher Wesley Niewoehner (2001) conducted an intensive analysis of Neandertal hand and finger bones, comparing them in detail to those of anatomically modern human beings. Niewoehner concludes that Neandertal hand anatomy indicates that they were capable of an enormously strong "power grip" in which objects are held in the palm with the fleshy part of the base of the thumb

TABLE 5.2 *Major Neandertal Specimens Discussed in Chapter 5*

COUNTRY	LOCALITY	FOSSILS	CRANIA	AGE (YEARS)	BRAIN SIZE (cc)
Germany	Neandertal	Skullcap			1,250
France	La Chapelle	Skeleton	"Old Man"		1,620
	Fontéchevade	Cranial fragments of several individuals		100,000	1,500
	La Ferrassie	8 skeletons		>38,000	1,680
	La Chaise	Cranium		126,000	
	St.-Césaire	Skeleton		36,000	
Belgium	Spy	Cranium			
Italy	Mt. Circeo	Cranium			
	Saccopastore	Cranium			
Yugoslavia	Krapina	Cranial and postcranial fragments of >45 individuals		Isotope stage 5	1,350 1,300
Israel	Tabun	Skeleton, mandible, postcranial fragments		60,000	1,270
	Amud	Skeleton		70,000	1,740
	Kebara	Postcranial skeleton		60,000	
Iraq	Shanidar	9 partial skeletons		70,000	1,600
				Mean	1,478.89
				Standard Deviation	165.68

Data from Day (1986).

Further, Neandertal skulls were marked with huge brow ridges like those of older hominin species, their lower faces protruded in an apelike fashion, and there was an enormous mass of bone at the rear (occipital) portion of the skull, where large muscles were attached that enabled the Neandertals to balance their large, heavy heads. The Neandertal face was large, with the lower portion far forward of the eyes and brows. The Neandertal nasal bridge was wide and flaring, and Neandertals lacked the thin, pointy chin that typifies modern human beings. The robust features and flat profile of the Neandertal head can be seen even in young Neandertals, including a 3-year-old Neandertal child from Gibraltar (Dean, Stringer, and Bromage 1986), an infant possibly as young as 6 months old from Amud Cave in Israel (Ponce de Léon and Zollikofer 2001), and even a neonate estimated to have been no more than 4 months old when he or she died (Maureille 2002). When you compare the appearance of the Neandertal crania included in this book (Figures 5.7 and 5.9) to the cranium of one of the Sima de los Huesos specimens (Figure 5.2), you can readily understand why many researchers refer to the Sima de los Heusos hominins as evolutionary ancestors of the Neandertals.

serving as a brace. In other words, if you were to shake a Neandertal's hand, you would need to be prepared to get yours crushed. Paleoanthropologist Fred Smith has succinctly summarized the anatomical data in this way: "Neandertals seem to represent the high-water mark for the genus *Homo* in favoring the brawn approach to environmental adaptation" (1991:225). Put another way, a spear-wielding Neandertal would have been an imposing adversary.

Mousterian: The stone-tool tradition of the Neandertals and early anatomically modern human beings.

Fossil Evidence

"CLASSIC" NEANDERTALS

The great florescence of the Neandertals in Europe and southwest Asia occurred between 80,000 and 40,000 years ago. Sites that have produced important Neandertal remains that are closely similar in morphology include Le Moustier, La Chapelle-aux-Saints, and La Ferrassie in France; Spy in Belgium; Saccopastore and Mt. Circeo in Italy; Krapina in Yugoslavia; Amud, Kebara, and Tabun in Israel (Figure 5.9); and Shanidar in Iraq.

NEANDERTAL CULTURE

Stone Tools

Named for the French Neandertal site of Le Moustier, the **Mousterian** tool-making tradition of the Neandertals represents not a replacement of the Levallois technique but rather a refinement. Mousterian flakes were smaller and more precisely made than the earlier Levallois flakes: The Neandertals were capable of producing flakes whose size and shape matched more precisely the form needed for a predesignated purpose. Instead of a single all-purpose tool like a handaxe or a few particular kinds of tools as in the earlier Levallois industry, dozens of different task-specific, standardized Mousterian tool types are recognized. Archaeologist François Bordes (1972) defined 63 specific Mousterian tool types for cutting, slicing, piercing, scraping, sawing, and pounding (Figure 5.10). Each Mousterian flake received more precise treatment once it was removed from the core. Whereas an Acheulean handaxe may have required as many as 65 blows of a hammerstone, the production of a highly specialized Mousterian tool required an additional hundred or more blows to shape and sharpen the edge once the flake was removed from its core (Constable 1973). The complexity of the Neandertal stone-tool assemblage clearly is the result of the complexity of what the Neandertals were doing with those tools.

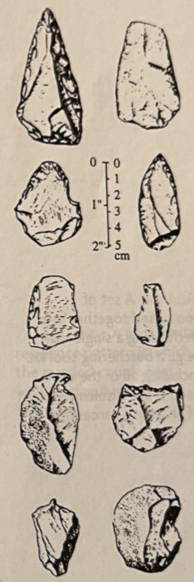


FIGURE 5.10
Typical Mousterian tradition tools, a variety of core and flake technology practiced by the Neandertals. *(From F. Bordes,* Mousterian Cultures in France. Science *134:803. © 1961. Reprinted with permission from American Association for the Advancement of Science)*

Subsistence

Though we cannot provide anything like a detailed breakdown of the Neandertal diet, there is some direct, if general, evidence of what items were on the menu. For example, investigators at Kebara Cave in Israel (Bar-Yosef et al. 1992) found evidence of an abundance of gazelle and fallow deer in the Neandertal diet. Evidence of burning and cut marks on their bones, as well as on those of elephant, horse, and several other mammalian species, shows the breadth of the animal subsistence base of the cave inhabitants. An abundance of carbonized seeds of wild been impossible without the help and care of his companions, indicating a level of care, at least during the healing process, that is usually associated only with modern human beings. That the Neandertals may have cared for the sick and wounded merely shows how similar they may have been to us.

Ancient Family

Modern Family is a much loved and highly awarded television show about, obviously enough, a "modern family" with its diverse mixture of formats, ethnicities, sexual orientations, age differences, and so on. Though it might seem a trifle morbid, if all of the characters in that show were now anthropological specimens, we might still be able to identify, at least in a general sense, who these people were, where they came from, and who was biologically related to whom through the application of the types of analysis discussed in Chapter 2 and mentioned throughout this book.

Just such an analysis has been performed on the remains of a dozen Neandertals, an apparent ancient family, recovered at the El Sidrón site in Spain (Lalueza-Fox et al. 2010). Genetic analysis in particular showed that the three adult males were all closely related to one another, but the three adult females were not close blood relatives of any of the males or of each other. Two of the children are genetically similar to one of the females; the other young child appears to be directly related to one of the other females. Those females may very well have been the mothers of those respective kids.

Notice that this pattern of closely related males and unrelated females living together in a group matches what was seen in Chapter 3 where a strontium isotope analysis of the diets of *Australopithecus* and *Paranthropus* also indicated that males remained in their region of birth throughout their lives while the females in the group migrated in from elsewhere. Among modern groups this practice is called **patrilocality**—males stay in the village or community into which they are born, their sisters move to other villages to find mates—following a general pattern in which females move into communities to become the mates of males to whom they are not related. In a preliminary conclusion, the authors suggest that Neandertals practiced a version of patrilocality.

Patrilocality: A postmarital residence pattern in which the married couple lives with the family of the husband.

Symbolic Expression

The creative or artistic impulse and the desire to use symbols in expressing that impulse might seem to be uniquely human traits. Did the Neandertals have that same desire?

Although there is no evidence that, as is commonly claimed in popular reconstructions, the Neandertals worshipped cave bears (Kurtén 1976), they do appear to have produced works of art. Recently, researchers discovered a cross-hatched design intentionally etched into the bedrock of the floor of Gorham cave in Gibraltar (Rodriquez-Vidal et al. 2014). The material immediately above the etching was dated to 39,000 years ago and the only stone tools found in the cave were Mousterian; so, in all likelihood, the etching was produced by a Neandertal. Examples of grooved or perforated bones, perforated animal teeth, polished ivory, and even geometrically incised bone and ivory have also been found at Neandertal sites (Bahn 1998; Chase and Dibble 1987; Simek 1992). At another site in France, peas found in the fireplaces is a direct indicator that the Kebara Neandertals also ate locally available vegetable foods.

Though a single kill may not give us a statistical measure of the contribution of hunting to the Neandertal diet, it can at least provide dramatic evidence that hunting was a part of the Neandertal behavioral repertoire. At the 50,000-year-old Umm el Tlel site in Syria, researchers found a shattered stone point still embedded in one of the cervical vertebrae (neck bones) of a wild ass (Boëda et al. 1999). Apparently, the stone had been hafted onto a shaft, likely of wood, and had been thrust so powerfully into the animal's neck that the stone weapon had shattered in two places, at its tip and base.

An isotope analysis of Neandertal bones further points to the importance of meat in their diet. The ratios of stable isotopes of carbon and nitrogen in the bones of carnivores and herbivores are demonstrably different and can be used as a relative measure of the proportion of meat and plant foods in the diet. When Neandertal bones recovered at the Vindija Cave site in Croatia were analyzed in this way, their carbon-to-nitrogen proportions were similar to those determined for contemporary carnivores, in particular, saber-toothed cats, and quite different from that same calculation performed on herbivores (Richards et al. 2000).

The extent of the faunal deposits at some Neandertal sites clearly indicates that these premodern human beings were proficient at obtaining meat for their diet. That they likely were successful hunters should not be surprising considering the enormous skeletal and muscular strength that would have provided Neandertal hunters the stamina necessary to walk great distances in tracking animals—and in Pleistocene Europe, in the snow and cold. Their ability to track down animals across great distances, their great physical strength, and their sophisticated **tool kit** would have made them formidable hunters indeed.

Tool Kit: A set of tools used together in performing a single task (e.g., a butchering tool kit including all of the tools used in the dismemberment of an animal carcass).

Compassion

It is often said that a society can be judged by how it treats its sick or injured. Ironically, evidence shows that the Neandertals, whose intelligence is so often maligned and who are so often used as a symbol for brutality, may actually have been compassionate and caring creatures. This suggestion stems from evidence of the survival of Neandertal individuals who had significant health problems or who had suffered severe trauma sometime during their lives. Some of these individuals had been in such bad shape that they probably could have survived only with the help of comrades.

For example, the Neandertal male who lived in Shanidar Cave in Iraq lived a rather eventful life, to judge by his skeleton, which showed several serious but healed bone fractures (Solecki 1971; Trinkaus 1983b). The bony ridge around his left eye had been fractured so badly that it is likely the blow blinded his eye. His right arm had been so severely smashed that the lower part had been amputated (perhaps by the blow, perhaps intentionally in an early example of surgical amputation). The right leg showed signs of disease and possible trauma.

It is clear this individual had sustained a series of heavy traumas at some time in his life and that rather remarkably he had survived. Such survival would have

FIGURE 5.12
In burying their dead, the Neandertals were exhibiting a behavior that shows their affinity with modern humans. This photograph shows the Neandertal burial found at the site of La Ferrassie in France. *(© Musée de l'Homme, Paris. M. Lucas, photographer)*

59 intentional burials. They point out that these burials make no sense as a mere hygienic way to dispose of a dead body. Why put that much time into digging a hole if a dead body can be far more unceremoniously dumped in the woods, allowing scavengers to do the work? They conclude that the Neandertals were burying their dead in recognition of the significance of death.

We should not conclude that Neandertals were just like us—had funerals, memorial services, and formalized cemeteries—but the questions raised by the intentional disposal of the dead practiced by the Neandertals may be more important than the answers we might suggest. Clearly, Neandertals understood the significance of death and recognized it through burial. Here again, these very different human ancestors exhibit their kinship to us.

ANATOMICALLY MODERN *HOMO SAPIENS*

Between 500,000 and 150,000 years ago, the hominin family appears to have been a complex tapestry with multiple threads represented by several significantly different regional variants of premodern humans. As we have just seen, by about 430,000 years ago, one of those threads began to differentiate, eventually evolving into the classic Neandertal form by about 125,000 years ago. It now appears that around the same time that the classical Neandertals were becoming established in Europe, and maybe a little before, another one of those hominin threads also had differentiated. This thread eventually developed a morphology that we can all examine directly, simply by looking in the mirror. It is us.

EXPLAINING THE EVOLUTION OF US

There is no unanimity among paleoanthropologists about the precise sequence of the evolution of anatomically modern *Homo sapiens*. There is also little certainty concerning how each of the premodern human fossils now being studied might fit into that sequence. Nevertheless, there is a broad and tentative consensus on these questions, which may be summarized in this way:

Consensus View

1. There is fossil evidence in Africa and nowhere else for the evolution of anatomically modern *Homo sapiens* from an older, premodern species. That evidence reaches back to about 200,000 years ago (Figure 5.13).

Evidence

African fossils like Bodo (600,000 years ago), Ileret (300,000 years ago), Ndutu (more than 200,000 years ago), and Kabwe are examples of Africa's premodern human beings. They are more recent than, and appear to be derived from, *Homo erectus* on that continent. They are primitive in appearance, with very large brow ridges, relatively small crania, foreheads that slope back, and lower faces that jut out.

Moving forward in time, the Florisbad (South Africa), Ngaloba (Laetoli Hominin 18, in Tanzania), and Jebel Irhoud (Morocco; Figure 5.14) crania all appear to represent forms transitional between those premoderns and modern-looking human beings. Their brain size is greater, their faces are flatter, their brow ridges are smaller, and their crania are rounder than the older fossils'. In those features they are, indeed, intermediate both in time and in morphology between the older premoderns and anatomically modern humans.

But then, at about 200,000 years ago, we see a shift toward modern morphology in the Omo I cranium discovered along the Omo River in southern Ethiopia in 1967 (Figure 5.15; Day 1969). The cranium was recovered from an ancient

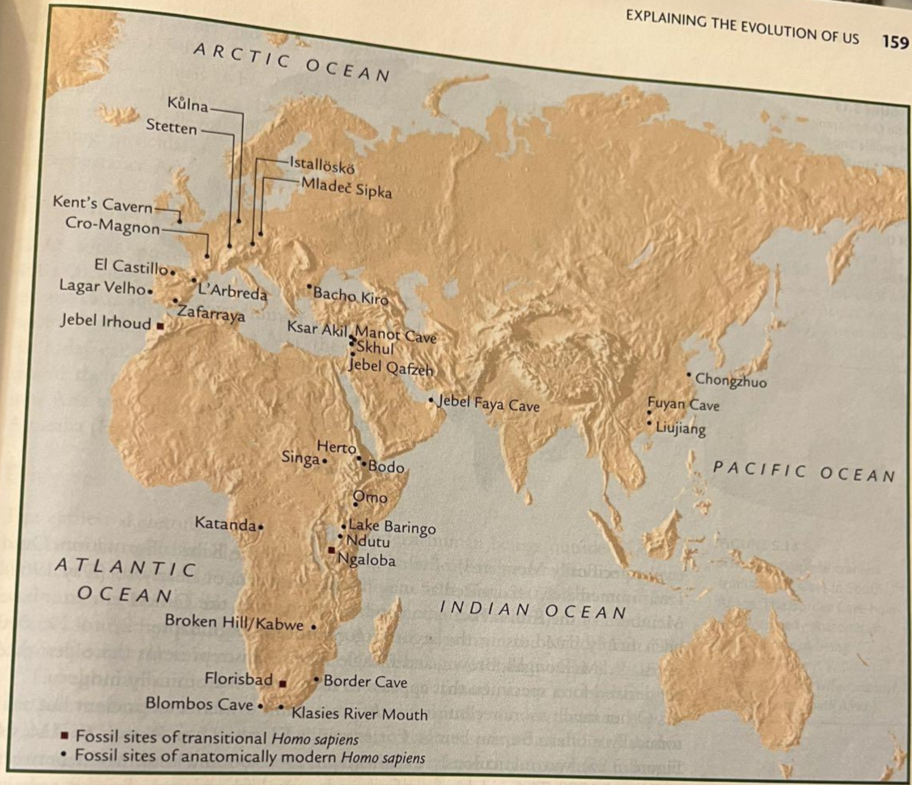


FIGURE 5.13
Fossil localities of early anatomically modern *Homo sapiens* and late, near-modern transitional forms.

FIGURE 5.14
The cranium from Jebel Irhoud in north Africa has been interpreted as representing a form intermediate between archaic and modern *Homo sapiens*. Some researchers contend that intermediate forms such as this one are found only in Africa. (© *Musée de l'Homme, Paris*)

FIGURE 5.15
The Omo I cranium. Round in profile and lacking a major bony protuberance in the rear (the occipital region), the Omo I cranium indicates a modern morphology. Recent redating of the sediments in which Omo I was recovered indicate that, at an age of 195,000 years, it is the oldest anatomically modern human fossil remain yet discovered. *(Courtesy of M. H. Day)*

layer (specifically Member I) of what geologists call the Kibish Formation. Omo I was immediately recognized as anatomically modern, or nearly so (Day 1969). Member I of the Kibish Formation and, by association, the Omo I cranium have been firmly dated, using the argon/argon procedure (Chapter 2), to 195,000 years ago (McDougall, Brown, and Fleagle 2005). This represents the oldest date yet derived for a specimen that appears to have been anatomically modern.

Other much more recent sites in Africa exhibit evidence of ancient but anatomically modern human beings. For example, Klasies River Mouth (KRM; see Figure 5.25) was meticulously excavated in 1966–68 and then again between 1984 and 1989. Thousands of artifacts and several fragmentary human remains were recovered, including two upper jaws, teeth, a lower arm (ulna), and cranial and mandibular fragments (Bräuer, Deacon, and Zipfel 1992; Deacon and Shuurman 1992; Rightmire 1984, 1991; Singer and Wymer 1982).

The morphology of the KRM specimens is modern. A modern human chin was clearly apparent in at least one of the mandibles, and the cranial fragments show no evidence of large brow ridges. Finally, ESR dating of animal teeth found in the same layer as the hominin fossils places the age of the specimens at about 90,000 years (Grün, Shackleton, and Deacon 1990).

The Border Cave site in South Africa has produced other examples of early anatomically modern human beings, including the remains of four hominins from different layers in the cave deposit: a complete mandible, a partial mandible, a fragmentary infant skeleton, and a fairly complete cranium (Rightmire 1979; Figure 5.16). Electron spin resonance (ESR) dates on animal teeth found in association with the hominin remains indicate that the cranium and partial mandible are probably more than 70,000–80,000 but less than 90,000 years old; the complete mandible is 50,000–65,000 years old; and the infant skeleton is

Arcy-sur-Cure, there are more than 142 such objects (Hublin et al. 1996). Perforated and painted shells have been found at two Neandertal sites in southeast Spain, Aviones cave and Antón rockshelter; both sites date to close to 50,000 years ago (Balter 2010a). Some of the perforated objects found at Neandertal sites may have been used in personal ornamentation—for example, as pendants (Figure 5.11). A recent analysis of eight eagle claws recovered at Krapina (in Croatia), a 130,000-year-old Neandertal site excavated 100 years ago, shows that they had been extracted from at least three birds with a stone tool and then worked into a necklace or bracelet (Radovčić et al. 2015).

What might the use of such possible ornamentation and etched designs tell us about the Neandertals? Even today, along with simply providing beautiful decoration, our jewelry may be intended to convey messages to others concerning our marital status, our economic position, our membership in a particular social group, or even our religion. It is an intriguing possibility that in wearing items of personal adornment, Neandertals may also have been conveying messages like these in a symbolic way.

Burial of the Dead

In at least one essential area, Neandertals behaved as we do: They buried their dead. At sites such as Le Moustier, La Chapelle-aux-Saints, and La Ferrassie in France; Teshik-Tash in Uzbekistan; Shanidar in Iraq; and Amud, Tabun, and Kebara in Israel, the evidence indicates that Neandertals interred their dead in the ground, most often in an intentionally flexed position, knees drawn up toward the chest, and even with some simple items such as stone or bone implements, ochre, or unmodified animal bone (Figure 5.12; Harrold 1980).

Archaeologists Anna Belfer-Cohen and Erella Hovers (1992) surveyed burial data for the Middle Paleolithic period of the Neandertals and counted

FIGURE 5.11
Though commonly viewed as unintelligent brutes, the archaeological record of the Neandertals belies this mischaracterization. These artifacts from the French site of Arcy-sur-Cure are tiny works of art, carvings that may have served as items of adornment made and worn by these significantly different, but fully human creatures. *(© Jean-Jacques Hublin)*

70,000–80,000 years old (Grün, Beaumont, and Stringer 1990).

The individuals who left behind these remains are us. If they sat down in the seat next to you in your college class, you wouldn't notice anything particularly strange about their physical appearance. And they appeared first in Africa.

Consensus View

2. At some point after 150,000 and before 100,000 years ago, descendants of these earliest anatomically modern human beings spread north, first into Southwest Asia, the area that we today call the Middle East. They then continued their spread west into Europe and east into Asia and, ultimately, the New World and Australia (Figure 5.17).

FIGURE 5.16
A nearly complete cranium from Border Cave in South Africa. The Border Cave hominin is an early anatomically modern human being. *(Courtesy of Professor P. V. Tobias, University of the Witwatersrand, Johannesburg, South Africa)*

Evidence

The earliest skeletons of anatomically modern human beings outside of Africa have been found in Israel, at the Skhul and Qafzeh sites now dated to somewhere between 96,000 and 119,000 years ago (Figure 5.18; Shea 2007). The recent discovery of the top of the cranium (technically, the **calvarium**) in Manot Cave in Israel is another example of a likely African migrant in the Middle East. The Manot specimen has been dated to 55,000 years ago (Hershkovitz et al. 2015).

Though hominin skeletons have not been found, stone tools dating to 123,000 years ago matching those seen at anatomically modern human sites in Africa have been found at the Jebel Faya site on the eastern coast of Saudi Arabia (Armitage et al. 2011). The people responsible for those tools may have followed a path north into Israel and then south and east into Arabia. Alternatively, ancient African moderns may have migrated directly into the Arabian peninsula over water, across the very narrow Bab al-Mandab Strait.

The descendants of these people, probably crossing the Persian Gulf and then following the Indian Ocean coast, arrived in India perhaps a little before 60,000 years ago, after a major volcanic eruption there (the Toba eruption) 74,000 years ago (though there is some intriguing evidence of their presence in the stratigraphic layer below the volcanic deposit, suggesting that they arrived before the eruption; Appenzeller 2012). The earliest anatomically modern human remains in east Asia (specifically, in China) are represented by 47 entirely human teeth recovered in Fuyan Cave (Wu 2015). The specimens date to between at least 80,000 and as much as 120,000 years ago. A 110,000-year-old mandible found at the Chongzhou site, also in China, adds additional evidence of a movement of modern humans into eastern Asia at about this time. The earliest fossils of hominins in Greater Australia (including New Guinea) date to after 50,000 years ago, and they are all anatomically modern (see Chapter 7). The oldest modern human remains found in Europe, at Kent's Cavern in

Calvarium: The top part of a skull, lacking the lower jaw (mandible) and facial bones.

the United Kingdom, are younger, dating to no more than 44,000 years ago (Higham et al. 2011). Anatomically modern people moved into the New World sometime after 30,000 years ago and across the islands of the Pacific just a few thousand years ago (see Chapter 7).

Consensus View

3. There were ancient hominins already living beyond the borders of Africa before the initial spread of anatomically modern human beings from that continent. They were the descendants of a previous movement of human ancestors out of Africa sometime around 1.8 million years ago, as reflected in the *Homo erectus* fossils found in Dmanisi, Georgia (Chapter 4). These first migrants out of Africa, by adapting to the new habitats into which they moved, experienced natural selection and evolved into a variety of hominins we call premodern. One of those premodern groups, represented by the fossils found at Sima de los Huesos, was the Neandertals. Neandertals were the hominins that anatomically modern African migrants encountered when they expanded out of Africa and into the Middle East

Evidence

The remains of Neandertals and anatomically modern humans have been found in a number of Israeli caves, some of which are in close proximity to one another. Dating techniques place the premodern and modern humans in their respective caves during the same periods and may even indicate that, in some cases, the modern humans are older than some of the Neandertals, having arrived there first.

For example, classic Neandertals have been excavated at Kebara Cave, as well as at the sites of Amud and Tabun (see Figure 5.9) in Israel. With their large, heavy skulls, large brow ridges, flattened occipitals, sloping foreheads, and prognathism, their form is unmistakably Neandertal. The Kebara site dates to 60,000 years ago. Amud is closer to 70,000, and Tabun has now been dated to about 100,000 years ago (McDermott et al. 1993).

These sites are broadly contemporaneous with the previously mentioned sites of Skhul and Qafzeh, also in Israel (see Figure 5.18). Skhul, on Mount Carmel, is not even 100 m (300 ft) from Tabun, with its Neandertal fossils, and Qafzeh is less than 30 km (18 mi) east of those two cave sites. Kebara Cave is also close by, about 10 km (6 mi) south of Mount Carmel. It is remarkable that such different-looking, generally contemporaneous hominins have been found in such a restricted area (see Figure 5.6 and 5.13). Combining the skeletal and archaeological evidence, Neandertals and anatomically modern human beings appear to have lived virtually side by side in Southwest Asia for thousands of years (Balter 2009b).

The oldest of the classic Neandertals are found in Europe and date to 125,000 years ago. The last of the Neandertals are also found in Europe. A detailed analysis of forty Neandertal sites in Europe shows that even as late as 45,000 years ago, the Neandertals were the dominant hominin group there. However, in just 5,000 years, the Neandertals were gone, having become extinct by about 40,000 years ago (Higham et al. 2014). The oldest remains of anatomically modern humans in

Europe are older than those of the last Neandertals. Thus, just as we saw in the Middle East, Neandertals and anatomically modern humans were contemporaries. The authors of a recent study (Higham et al. 2014) estimate that Neandertals and modern humans overlapped in time for somewhere between 2,600 and 5,400 years.

Consensus View

4. Where Neandertals and anatomically modern human beings overlapped in time and space, gene flow occurred between these two different versions of human beings. That's just the technical way of saying there is clear evidence of interbreeding between the two groups.

Back in the 1960s and 1970s, a common poster hung in college dorm rooms across America read: "Make Love, Not War." A noble sentiment, to be sure, but probably not as realistic as a parody of that poster which read: "Make Love AND War." I say "realistic" for this reason: Even in times of war, mortal enemies often find time between pitched battles to, like the poster says, "make love" (sometimes it's by force and not the result of love, but sometimes it's consensual).

It appears that whatever the general relationships were between the geographically and temporally overlapping premodern and anatomically modern human beings, love, or at least sex, took place. I admit to having the silly fantasy of some terrified young Neandertal woman bringing home an anatomically modern boyfriend to meet her father; that would have been quite a scene, I imagine. But we know it happened, at least the sex part, because of the following astonishing fact; many groups of modern human beings carry Neandertal DNA in their genome. If your ancestors came from Europe or Asia or if you are a descendant of aboriginal Australians or Native Americans, you are part Neandertal—albeit a small part. In fact, only if all your ancestors came from Africa will you possess no Neandertal DNA.

Evidence

Working like crime scene investigators trying to determine the identity of the fragmentary remains of a murder victim, researchers have now reconstructed full nuclear DNA sequences—the genomes—from the remains of a number of Neandertals at several sites (Green et al. 2010; Prüfer et al. 2014). The genome reconstruction by Green et al. (2010) was based on a combined analysis of remains from the Vindija Cave in Croatia (dated to 38,000 B.P.), El Sidron in Spain (49,000 B.P.), the Neander Valley site in Germany (40,000 B.P.), and Mezmaiskaya in southern Russia (between 60,000 and 70,000 B.P.). The genome sequence by Prüfer et al. (2014) was based on the remains of a Neandertal female who lived in the Altai Mountains of Siberia at least 50,000 years ago.

Overall, the derived Neandertal genomes are quite similar to the genome of modern humans, showing that, though we may have looked quite different from each other, under the skin we shared a lot in common. There were, however, discernible and significant differences between Neandertals and modern human beings. Importantly, in 212 specific regions of our genetic instructions,

FIGURE 5.17
The geography and chronology of the expansion of anatomically modern human beings out of Africa from their initial appearance there 200,000 years ago.

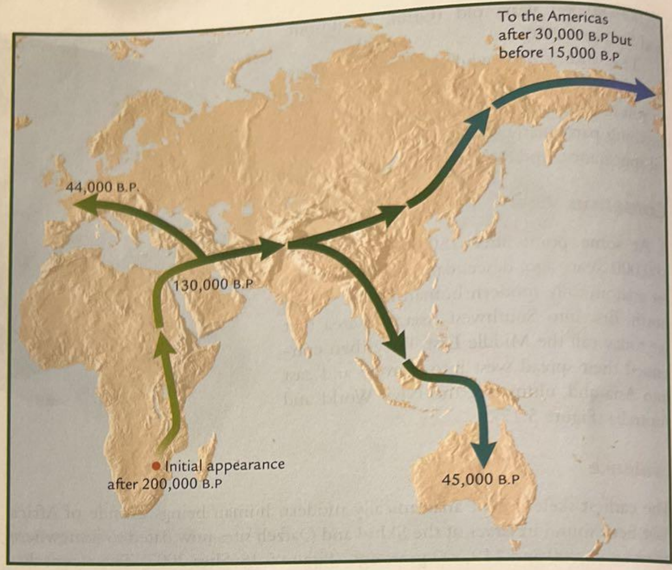
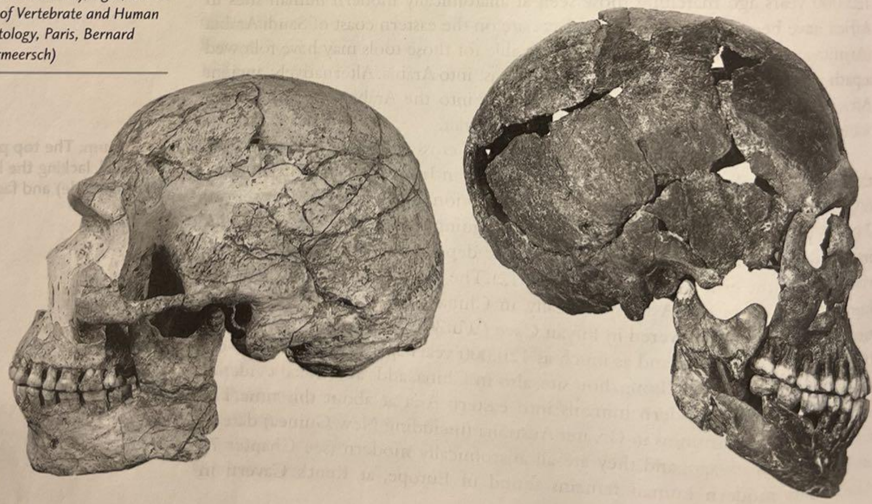


FIGURE 5.18
The Skhul (left) and Qafzeh (right) skulls from Israel are quite modern in appearance. Neandertals lived in Israel at the same time. *(left, © President and Fellows of Harvard College, Peabody Museum of Archaeology and Ethnology, PM# 46-49-60/N7365.0 (digital file# 136660006); right, Laboratory of Vertebrate and Human Paleontology, Paris, Bernard Vandermeersch)*



we modern humans exhibit forms not seen in any of the Neandertals (Green et al. 2010:717). Probably not coincidentally, one of those genetic discontinuities between the Neandertals and us controls a certain morphological characteristic of the skull—specifically a protruding forehead—seen in modern humans but not in Neandertals, whose foreheads sloped back at a sharp angle. So, the metaphor of the forensic investigator of a crime scene can be extended: Even with only a DNA sample in hand, a crime scene investigator would be able to determine if the murder victim had been a modern human being or a Neandertal.

One of the most fascinating results of the genome studies was the discovery of small stretches within the genetic signatures of some modern human populations—specifically in Europe and Asia—not seen in other modern people, but that are the same as those seen in the Neandertal genome. This was almost certainly the result of ancient interbreeding between the groups. The genetic signal of that interbreeding is apparent on both sides of the equation; modern human DNA has now been detected in a 100,000-year-old Siberian Neandertal as well (Khulwilm et al. 2016).

The amount of Neandertal genetic intrusion into the anatomically modern human genome is quite small, representing only about 1%–3% (Vernot and Akey 2014), and reflects a pattern of strong though certainly imperfect separation between the groups when they coexisted. This small percentage does not mean that interbreeding was exceedingly rare. Though each individual non-African human has only about 1–3% Neandertal DNA, altogether, about 20% of the Neandertal genome is found somewhere in the modern human population (Vernot and Ackey 2014). So yes, there's plenty of evidence in modern people that in the past, our ancestors and Neandertals were getting busy.

We can even suggest about when some of this admixture took place. This same percentage range of Neanderthal DNA found in modern humans outside of Africa is also found in ancient anatomically modern human skeletons in Eurasia. About 2% of the genome derived from a 36,200-year-old modern human skeleton found at the Kostenki site in Russia was derived from a Neandertal ancestor (Seguin-Orlando et al. 2014). A skeleton found at the Ust'-Ishim site in western Siberia, dating to 45,000 years ago, also has about 2% Neandertal DNA (Qiaomei Fu et al. 2014), with longer intact sequences of Neandertal DNA than those found in modern people. This suggests that the intrusion of Neandertal DNA in this specimen had occurred in his ancestors somewhere 7,000 and 13,000 years before he was born. So, at least in his family line, the interbreeding occurred between 52,000 and 58,000 years ago.

Biologist Michael Lachman (in Rosen 2014) makes this interesting analogy to show the significance of even a small percentage of Neandertal DNA in most modern human groups. If you have 2% Neandertal DNA, you share approximately the same amount of your genome with your great-great-great-great-grandmother as you do with the Neandertals. No, that doesn't mean your great-great-great-great-grandmother was a Neandertal; it just means that you carry about the same amount of genetic material from that family ancestor as you do from the Neandertals. That's amazing.

Interbreeding between Neandertals and anatomically modern humans who lived in the same regions at the same time may also be borne out by skeletal evidence. The excavators of a 24,500-year-old fossil from the Lagar Velho site near Lisbon, Portugal, believe this specimen represents a Neandertal/anatomically modern human hybrid (Duarte et al. 1999; Zilhao and Trinkaus 2003). The bones are those of a 4-year-old boy. The cranium was crushed, but the mandible was only somewhat damaged and looks like the lower jaw of a modern human child, much as one might expect for the given date. Furthermore, the boy had been carefully buried in a manner typical of modern human beings in Spain and Portugal dating from the period around 25,000 years ago. However, a careful analysis of the postcranial skeleton revealed that the young boy had an extremely robust body, with a wide, barrel chest and proportionally short arms and legs. In other words, the bodily proportions of the Lagar Velho child, along with some detailed skeletal characteristics, were Neandertal-like. The paleoanthropologists who analyzed the remains describe the skeleton as a "morphological mosaic" and believe that the mixture of modern and Neandertal traits seen in the child's skeleton is the result of a long-term pattern of interbreeding between contemporary anatomically modern human beings and Neandertals (Duarte et al. 1999:7608).

We can summarize the implications of the reconstruction of the Neandertal genome and skeletal evidence of interbreeding in this way:

1. The majority of the modern human genome can be traced to our anatomically modern human ancestors who originated in Africa. Whatever human modern population you sample today, we all share a common genetic heritage, and that heritage is traceable to anatomically modern human beings who appeared in Africa nearly 200,000 years ago.
2. A small but significant percentage (between 1% and 3%) of the genome of modern humans who can trace their ancestry to Europe and Asia originated in Neandertal populations.
3. Modern Africans do not possess any of the Neandertal DNA signature. This is almost certainly because Neandertals didn't live in Africa, so anatomically modern human beings could not have encountered or mated with Neandertals until after they had migrated out of Africa.

Consensus View

5. There's a ghost in our family tree. A hidden skeleton in the human closet. A long-lost relative that mucks up our family links on ancestry.com. I'll stop. What I'm referring to here is a fascinating new wrinkle, a so-called ghost lineage in the human genealogy that has only shown up recently. And his name is Denis. Well, sort of.

In a discipline marked by some really interesting names for hominin fossils ("Neandertal," "Java Man," the "australopithecines"), the "Denisovans" doesn't quite seem to measure up. Denisovans, to me, sounds more like a name we might apply to members of a religious cult who revere their leader—you know, Denis. They have a compound in Idaho.

In reality, the Denisovans are named for the Denisova Cave in southern Russia, near its border with Kazakhstan, where their (so far) rather meager remains have been found. It's not the number of remains that makes the inhabitants of Denisova Cave so interesting; it's the level of preservation of genetic material recovered from a finger bone that has caused most of the excitement.

Artifacts have been excavated in stratigraphic levels of the cave that date to between 30,000 and 48,000 years ago. Some of the artifacts are pretty typically Mousterian and, therefore, attributable to a Neandertal presence in the cave. Some of the artifacts have been labeled Upper Paleolithic (Chapter 6) and likely were made by anatomically modern humans. Researchers expected the DNA recovered from the finger bone to be diagnostic of either Neandertal or anatomically modern humans. It turned out not to be diagnostic of either of these groups but, instead, reflected the genome of another type of human being altogether. A careful analysis of the Denisovan genome suggests that the bone belonged to an archaic human group, different from both modern humans and Neandertals, but similar enough to the latter to suggest that they were "sister groups" who shared a common ancestor (Reich et al. 2010). In other words, based on a comparative analysis of the genomes of Neandertals and the Denisovans, it would appear that they diverged from a common root of pre-modern humans (Figure 5.19). That divergence occurred long ago enough to have resulted in the degree of their genetic difference. However, Neandertals and Denisovans are more similar to one another than either is to anatomically modern humans, meaning that the premodern line that led to anatomically modern humans branched before the Neandertal/Denisovan line went its not-quite-separate way. Prüfer and his collagues (2014) estimate that, based on their analysis of recovered DNA, the split between Neandertals and anatomically modern humans occurred about 550,000 years ago (which conforms pretty well to the pre-Neandertals at Sima de los Huesos, with their date of 430,000 years ago), while the split between Neandertals and the Denisovans occurred more recently, perhaps less than 400,000 years ago. The Sima de los Heusos pre-Neandertals share a part of their mitochondrial DNA signature (their mtDNA, which is inherited only in the maternal line), indicating a genetic connection between these two groups despite the geographic distance between their core locations, Western Europe for the pre-Neandertals and East Asia for the Denisovans (Meyer et al. 2014).

Just as we saw in the comparison of the Neandertal and anatomically modern human genome reconstructions, geneticists have found that a snippet of Denisovan DNA is present in the modern human genome, but is not found among modern Europeans. Specifically, it represents about 5% of the genome of some modern human populations in East Asia, especially in Melanesia, the Philippines, and among the aboriginal people of Australia (Gibbons 2011c; Rasmussen et al. 2011). Native Americans are derived from Asia (Chapter 7), so it is not surprising that Denisovan DNA shows up in that population as well (though at less than 1% in the average Native American (Prüfer et al. 2014)).

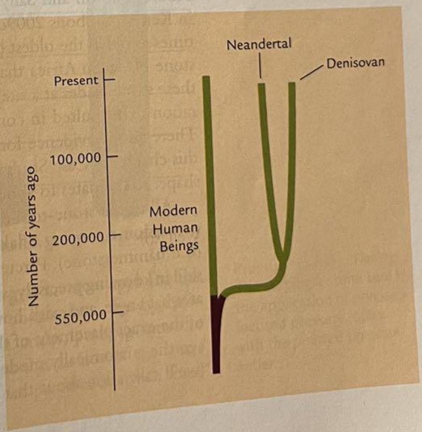


FIGURE 5.19
One view of the chronological and genealogical relationships among anatomically modern human beings, the Neandertals, and the Denisovans. There is evidence of some gene flow—interbreeding—between anatomically modern humans and Neandertals and between anatomically modern humans and Denisovans.

Stone Tools of Anatomically Modern Human Beings: Utilitarian Works of Art

These first fully modern (by anatomical measures) human beings developed sophisticated stone and bone tools, and produced complex forms of symbolic expression that we today recognize as art (see the discussion in Chapter 6). Paleoanthropologist John Shea characterizes these first human beings as having been "cognitively advanced" as soon as they appear on the scene (as cited in Balter 2013). We see that very clearly in their ability to make very sophisticated tools that required multiple and precise steps in their production. We say that their tool production took much greater "planning depth" than previous stone tools—and it was highly efficient in producing sharp and durable edges from the raw material.

Assessing the sophistication of a stone-tool technology can be a bit subjective. It may be difficult to state, categorically, that one technology is "more advanced" or "more sophisticated" than another. Ordinarily, a technology that (1) requires a greater number of steps and more forethought in preparing a stone core, (2) results in greater efficiency (producing a greater amount of usable edge), and (3) produces tools that simply do the job better because they are sharper or more aerodynamic is considered to be more advanced or sophisticated (Figure 5.20).

Blades: Long thin stone flakes, commonly twice as long as they are wide. Blades represent an efficient use of stone, producing a high proportion of edge for the amount (weight) of stone used.

A technology that produces **blade** tools fits these criteria for increased sophistication. The production of long, thin, sharp blades of a consistent size and shape ordinarily requires more preparation of the stone core from which the blades are struck, results in a more efficient use of the stone, and produces proportionally more cutting edge from the same amount of stone than in the Mousterian technology. And, in fact, when we look to Africa, we see evidence of the production of blade tools long before they turn up in Europe or Asia.

The oldest stone blade tools have been found in Africa by researchers Cara Roure Johnson and Sally McBrearty, at five sites located in the Baringo Basin, in Kenya (Gibbons 2009d). The sites date to an amazing 500,000 years ago, ten times as old as the oldest blade tools found in Europe. McBrearty has also found stone blades in Africa that date to 240,000 years old (Gutin 1995). She found these stone blades at a site near Lake Baringo, and they show careful core preparation that resulted in consistently sized and shaped stone blades (Figure 5.21). There also is evidence for blade tools at Klasies River Mouth (Figure 5.22; see this chapter's "Case Study Close-up"). The tools are quite consistent in size and shape. KRM dates to about 90,000 years ago.

All of the stone-tool technologies discussed so far in this book are based on percussion, removing a flake by striking one stone (the object piece) with another (the hammerstone). Percussion flaking certainly takes a tremendous amount of skill in knowing precisely where to strike the object piece with your hammerstone, at what angle, and with how much force. For greater precision and more control of the exact placement of the force on the object piece, however, by 75,000 years ago the anatomically modern human residents of Blombos Cave in South Africa (we'll talk a lot about that site in Chapter 6) used another procedure (Mourre,

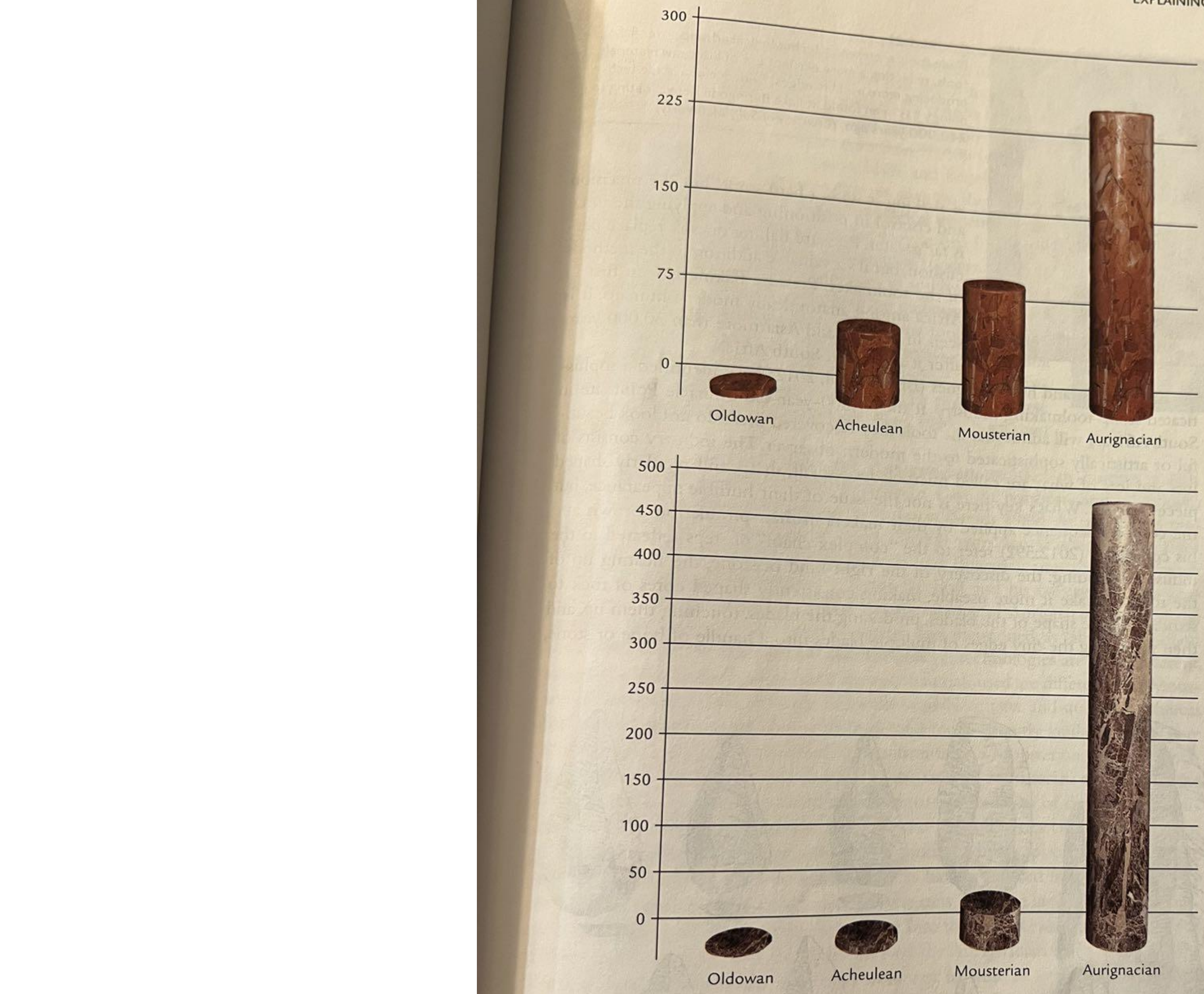


FIGURE 5.20
Archaeologists, including me, often label a tool or a technology "sophisticated" without defining what they mean by that. These two figures reflect what I mean when I call the lithic technology of anatomically modern humans more sophisticated than the technologies of premodern humans. The top graph shows the number of applications of force needed to produce a finished tool in each labeled technology (from oldest to most recent, left to right on the horizontal axis). The bottom graph shows the number of inches of sharp edge produced from each pound of rock (in the same order). Simply put, the Aurignacian tool technology of anatomically modern human beings required more steps and produced more usable edge than previous technologies. That's what I mean when I call it more sophisticated than previous technologies.

Villa, and Henshilwood 2010). Called **pressure flaking**, it involves applying the force necessary to remove a flake, not by striking the object piece, but by carefully positioning the hard tip of, in all likelihood, an antler, pushing into the edge of a stone, and virtually peeling off a flake across the surface of the stone (Figure 5.23). Pushing at an edge with an antler does not produce as much force

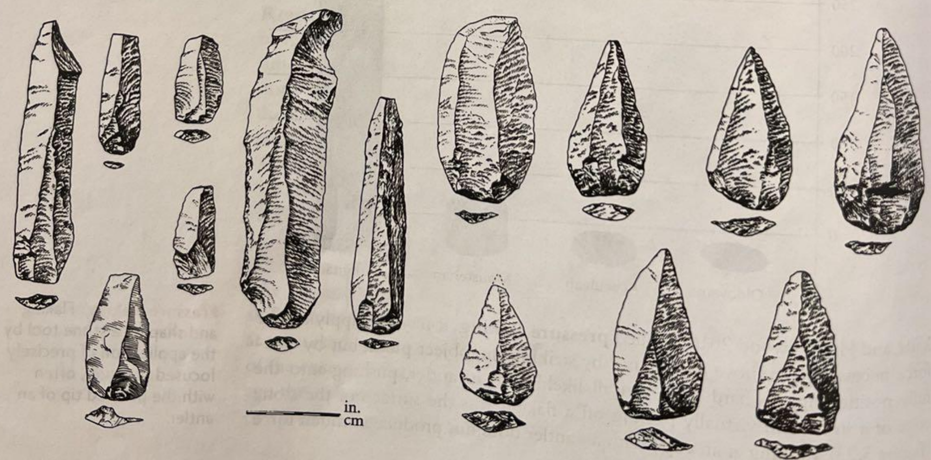
Pressure Flaking: Flaking and shaping a stone tool by the application of precisely focused pressure, often with the pointed tip of an antler.

FIGURE 5.21
Blade tools represent a technological advance over flake tools, reflecting a more efficient use of lithic raw materials, producing more useable edges. Evidence of a blade technology has been found at Lake Baringo in Kenya, dating to 240,000 years ago. *(Courtesy of Sally McBrearty)*

as striking it with a hard stone, but the precision and control in positioning and applying the force is far greater. Pressure flaking doesn't replace percussion, but it's a valuable addition to the methods of the toolmaker. Pressure flaking is seen first in Africa among anatomically modern humans. It is seen in Europe and Asia more than 30,000 years after it appears in South Africa.

Kyle Brown and his colleagues (Brown et al. 2012) have identified a sophisticated stone-toolmaking industry at the 71,000-year-old Pinnacle Point site in South Africa. I will admit that the tools they discovered there do not look beautiful or artistically sophisticated to the modern observer. The industry consists of lots and lots of what are called microblades—small, sharp, and regularly shaped pieces of rock. What's key here is not the issue of their humble appearance, but the complex sequence applied by their makers in their production. Brown and his colleagues (2012:592) refer to the "complex chain" of steps reflected in the industry, including: the discovery of the right kind of stone, the heating up of the rock to make it more useable, making consistently shaped cores of rock to standardize the shape of the blades, producing the blades, touching them up, and then mounting the tiny edges of multiple blades into a handle of bone or stone,

FIGURE 5.22
Long blade tools dating to close to 100,000 years ago from the site of Klasies River Mouth, South Africa. These tools were associated with fragmentary remains of anatomically modern human beings. *(From* The Middle Stone Age at Klasies River Mouth, South Africa, *by Ronald Singer and John Wymer, University of Chicago Press, 1982)*



and probably using some sort of adhesive to keep the bladelets firmly in place in the handles. That's a bunch of steps to keep track of and a bunch of steps to pass down to the next generation of toolmakers. That complexity reflects the great intelligence of the anatomically and intellectually modern inhabitants of southern African more than 70,000 years ago.

The Middle Stone Age African blade and bone tools do not appear to have accompanied their makers on their migration to Asia. In fact, there is no archaeological evidence in the form of an alien or invasive tool technology in Asia that might mark the arrival of immigrant, anatomically modern Africans. The earliest modern-looking hominins in southwest and east Asia practiced the same stone-toolmaking tradition as the local, indigenous, archaic-looking people. The stone-tool assemblages from Skhul and Qafzeh, with their modern-looking fossils, and nearby Tabun, with its contemporary, archaic-looking fossils, exhibit the same stone-tool tradition: The people at these sites were all making Mousterian tools (Shea 1990; Thorne and Wolpoff 1992).

FIGURE 5.23
Two beautifully flaked tools excavated at Blombos Cave in South Africa. The edges of the tools were precisely shaped and sharpened, not through the application of force by percussion but by precisely applying pressure with a pointed tool, probably the narrow tip of an antler. *(From "Early Use of Pressure Flaking on Lithic Artifacts at Blombos Cave, South Africa," by Vincent Mourre, Paolo Villa, and Christopher S. Henshilwood, Science 330:6004. Reprinted with permission from AAAS.)*

The earliest sites exhibiting the **Aurignacian** tradition in Europe include L'Arbreda Cave in eastern Spain, El Castillo Cave in northern Spain, Istállöskö in Hungary, and Bacho Kiro Cave in Bulgaria (Straus 1989). As mentioned previously, the Spanish sites date to about 38,000 years ago (Bischoff et al. 1989; Valdes and Bischoff 1989); the Hungarian and Bulgarian sites date to as much as 43,000 years ago. Archaeologist James Bischoff and his colleagues, who analyzed the Spanish sites, characterize the appearance of Aurignacian tools in the Spanish caves, as well as the other European sites mentioned, as "abrupt" (Bischoff et al. 1989:573). The Mousterian and Aurignacian technologies are quite different, and, in the case of the Spanish sites, the raw materials used are different: The Mousterian flakes are almost all made of locally available quartz and quartzite, whereas the Aurignacian tools are almost all made of a more distantly available flint. There is no evidence there of a slow, steady transition from a Mousterian to an Aurignacian tradition, no sign of an evolution of the simpler Mousterian tradition of the Neandertals to the more sophisticated Aurignacian tradition of the first anatomically modern humans in Europe. Bischoff and his colleagues take this to suggest population replacement; when a new toolmaking tradition appears abruptly in the archaeological record, with no evidence of its having evolved from an earlier way of doing things, it is often concluded that the new tradition arrived from the outside, the product of a new group's migration into the area. Researcher Paul Mellars (2004) also points out that the dates derived for Aurignacian sites across Europe imply a wave of population expansion from east to west. In other words, the first Aurignacian sites, generally, are oldest in the Middle East, a bit more recent in eastern Europe, and successively younger as one moves to the west. This is exactly the pattern we would expect if the bearers of that technology were migrants from the Middle East, expanding their territory westward across Europe through time.

Aurignacian: Lithic tool technology associated with anatomically modern human beings in Europe about 40,000 years ago. Includes long, narrow blade tools.

Soon after the blade-based Aurignacian tradition arrived in Europe along with anatomically modern people, rather interestingly the Mousterian tradition

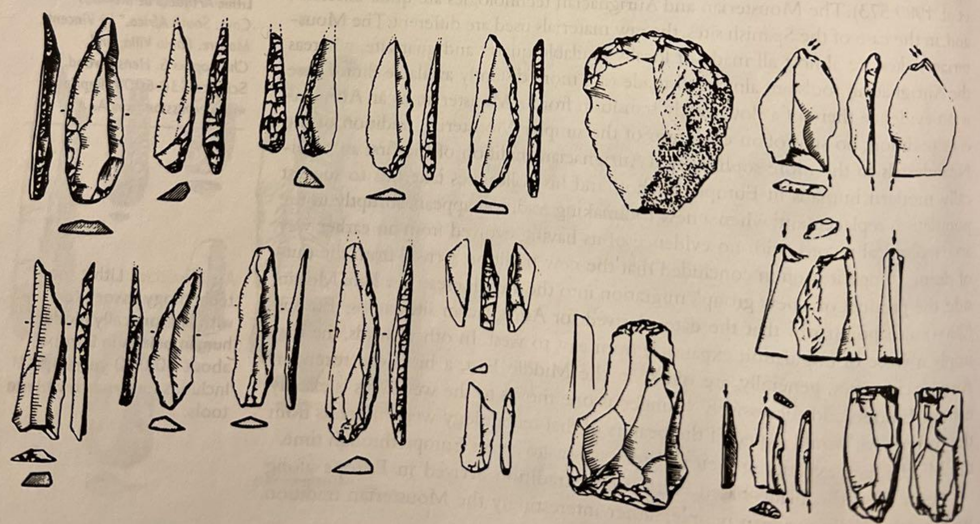
Châtelperronian: Lithic technology including the use of blades that appears to be intermediate in form and time between Mousterian and Aurignacian. Associated with some late populations of Neandertals.

of the resident Neandertals began to change. The Neandertals began to produce tools that look more like the blades being produced by the incoming anatomically modern humans. It appears as though the native Neandertals and the anatomically modern migrants were, at least, aware of each other, and the Neandertals appear to have been picking up some of the toolmaking practices of the newcomers.

The best known of these apparently hybridized technologies is the **Châtelperronian**, in France, seen at Neandertal sites like Saint-Césaire and Arcy-sur-Cure (Figure 5.24). This technological tradition has much in common with the Mousterian and differs only in the addition of long, thin blade tools, exactly the kind of tools that characterize the Aurignacian tradition. Elsewhere in Europe the situation may have been repeated, and other "hybrid" tool traditions are suggested for Italy, Greece, and central Europe (Gibbons 2001). This suggests a fascinating scenario of contact between two fundamentally different kinds of human beings in Europe after 40,000 years ago.

A careful analysis of the Châtelperronian blades shows that their production was somewhat different from Aurignacian blades. In other words, Neandertals had not simply watched anatomically modern humans produce blade tools and then unquestioningly copied each of the steps (Bahn 1998). Châtelperronian is rather short-lived, dated between about 36,000 and 33,000 years ago. Châtelperronian artifacts are sometimes found in the same sites as Aurignacian but separated stratigraphically; they are sometimes even interdigitated, with Châtelperronian tools in layers sometimes above Aurignacian tools, sometimes below (and sometimes both), such as at Le Piage in France (Simek 1992). This indicates fairly clearly that they were produced by separate groups who inhabited these sites at different times. The Châtelperronian, therefore, can be interpreted as supporting a model of population replacement.

FIGURE 5.24
Tools of the Châtelperronian tradition. Tools like these were found with the St. Césaire Neandertal. It has been suggested that this tradition represents a cultural blending of the Neandertal Mousterian and the anatomically modern human tradition called Aurignacian. *(Adapted from Bordes and Labrot 1967)*



WHY ARE THE NEANDERTALS EXTINCT?

The timing certainly is suggestive. The earliest evidence for the presence of anatomically modern human beings in Europe is now dated to about 41,000 years ago (Benazzi et al. 2015). This matches closely with the dating for evidence of the last hurrah of the Neandertals in Europe. Correlation does not necessarily prove causality, but it certainly is suggestive in this instance. Did modern human beings contribute to the extinction of the Neandertals?

The Neandertals and other premodern humans certainly are extinct, having been replaced by anatomically modern human beings. In the view presented in this book, the Neandertals were not the immediate ancestors of modern people but rather a side branch of human evolution, at least partially overlapping in time with anatomically modern human beings. What significant advantages did the early anatomically modern humans have over the premoderns that led to the survival of the modern humans and the extinction of the premoderns?

As alluded to in Chapter 2, the human skeleton preserves a record of dietary deficiencies suffered during its developmental years. For example, **Harris lines,** cracks on the ends of long bones (arm and leg) that result from dietary deficiency during the developing years, and **enamel hypoplasia**, zones of thin tooth enamel that result from unmet nutritional needs during early childhood, are present to a far greater degree in Neandertal remains than in the remains of early anatomically modern human beings. Marsha Oglivie, Bryan Curran, and Erik Trinkaus (1989), for example, found evidence of hypoplasia in the enamel of 36% of 669 Neandertal teeth, reflecting an estimated incidence of 75% in the individuals represented. This is more than double the incidence in nutritionally stressed recent human samples (Oglivie, Curran, and Trinkaus 1989:30). Other studies have produced similar results (Brennan 1991; Molnar and Molnar 1985). As Olga Soffer (1994) points out, this paleopathological evidence indicates that Neandertal children suffered far more physical stress than did their anatomically modern contemporaries.

Archaeologist Mary Stiner (1994) has determined that anatomically modern humans were more adept than the Neandertals at wringing every last bit of nutrition out of those foods that were available in Pleistocene Europe. Neandertals broke open animal bones to extract the rich protein of the marrow, whereas anatomically modern humans boiled the bones to get at the same food source. Stiner estimates that you can extract twice as much fat out of a bone by boiling it (as cited in Balter 2001).

This superiority of the cultural adaptation of the early anatomically modern human beings appears to have been the key to their success. Even though the Neandertals appear to have been biologically better adapted than anatomically modern human beings to the cold, through the invention and application of a superior cultural buffer that may have included warmer, tailored clothing, superior hearths, and so on, anatomically modern humans were actually better able to survive the cold than the Neandertals. Through reconstruction of local climate conditions where the archaeological sites of Neandertals and anatomically moderns have been found in Europe, researchers Leslie Aiello and Peter Wheeler have shown that the locations where anatomically modern humans lived had median temperatures (specifically, windchills) that were between 4 and 7 degrees Celsius *colder* than the Neandertal sites (Balter 2004a).

ISSUES AND DEBATES

Harris Lines: Longitudinal cracks located at the ends of long bones; indicative of dietary stress during physical development.

Enamel Hypoplasia: Medical condition affecting the outside layers of teeth. Horizontal cracks develop on the enamel in individuals who experience bouts of malnutrition during their early years.

However we explain it, the archaeological record clearly shows that while Neandertal populations were declining, the population of anatomically modern human beings was experiencing an explosion. Researchers Paul Mellars and Jennifer French (2011) performed a meta-analysis of the archaeological assemblages in western Europe. Specifically, they looked at the number of sites, the sizes of each site, and the density of tools at those sites dating to the Late Pleistocene. Though, of course, we don't have census data for this period, the authors used the variables of site count, size, and artifact density as proxy measures for population size. They then compared the numbers for late Neandertal and early AMH sites. The authors concluded that there was as much as a 10-fold increase in population between the time of Neandertal dominance and AMH replacement in Europe after 40,000 years ago. This would seem to represent another clear picture of Neandertals fading away into extinction while our anatomically modern direct ancestors thrived.

Our anatomically modern human ancestors were not precisely adapted to the environmental conditions of late Pleistocene Europe, as were the Neandertals, and this likely contributed to their survival. They were not locked into a particular set of environmental circumstances, and when those conditions changed dramatically, they simply were not affected as severely. The essence of the modern adaptation is cultural flexibility, the ability to respond, even to rapid and dramatic environmental changes, by inventing new technologies and approaches to subsistence, housing, clothing, heating, and so on. The key behavioral advantage of modern human beings is our flexibility, that is, our ability to adapt to a wide range of conditions, and this may have meant the difference between survival and extinction in the late Pleistocene.

THE NEANDERTALS: A SEPARATE SPECIES

You may have heard the following in your high school biology class: We define a species by the capacity of individual males and females to mate and produce fertile offspring—offspring which also have the capacity to reproduce when they mate with other members of their species. So, we draw tightly bounded rings around populations of animals with impenetrable borders between them and all other animals. Males and females within the ring can mate and produce fertile offspring, but they can't accomplish this with critters positioned within the borders of other rings.

As you probably know, there is a complication here, and there's at least a little bleed through between adjacent rings. There are different species that are so closely related genetically—they reside in rings that are very close together—that they can mate (or combine through artificial insemination) and produce offspring, but those offspring are sterile, unable to have offspring of their own. Horses and donkeys, for example, can mate and have foals, but those babies are sterile. People have created fascinating combinations of lions and tigers (called ligers and tigons). They're beautiful hybirds, but they're sterile. There are other examples.

However, as is the case in so many attempts we make to categorize the world around us into simple, discrete, and bounded categories, it turns out that nature is far more complex. Often, what we perceive—or want to perceive—as separate, discrete, and inviolable categories are better understood as segments along a lengthy continuum separated by few, if any, impermeable boundaries. The arrangement of life on the planet reflects this pattern of continuity.

For example, wolves and coyotes are separate species, but they reproduce in nature and produce fertile hybrids called coywolves. So it is entirely possible that the Neandertals, a different species from us, were able to mate with our ancestors and produce offspring, even fertile offspring, thus explaining the Neandertal DNA present in the modern human genome outside Africa.

But those hybrids didn't thrive, at least not statistically. The percentage of the penetration of Neandertal DNA into the modern human genome appears to have always been low. As researcher David Reich suggests (in Gibbons 2014:471), perhaps this means that "when Neanderthals and modern humans mixed, they were at the edge of biological compatibility." In other words, we were just barely genetically similar enough to produce fertile offspring. As a result, while the Neandertals still reside within us as a faint shadow, we are, ultimately, not Neandertals.

OUR HOMININ RELATIVES: GENETIC GIFTS, GENETIC BURDENS

At some time in our lives, many of us look at our relatives, especially our parents and grandparents, and either thank or curse them for the genetic legacy they bequeathed to us. Maybe we appreciate the longevity that appears to run in the family, are grateful for those piercing blue or deeply brown eyes they passed down to us, or are thankful for our inherited metabolism that allows us to eat whatever we want and not gain any weight. On a more serious note, perhaps we live in fear because so many of the women in our female line have been confronted by breast cancer or so many of the men in our lineage have died young of heart disease. All of us are the genetic product of the generations that preceded us, both for good and for bad, and, it turns out, that includes our Neandertal ancestry.

It has been suggested by a number of researchers that some Neandertal genes that appear in the modern human genome as a result of our interbreeding actually benefitted those humans who carried them. For example, a segment of the Neandertal genome present in modern human beings appears to control the production of keratin filaments (Sankararaman et al. 2014). Keratin is used in our production of teeth and hair. Researchers have suggested that the enhanced keratin production inherited from cold-adapted Neandertals was advantageous to our otherwise tropically adapted ancestors as they expanded into the European Pleistocene.

At the same time, another study shows that, though most non-Africans have about the same amount of Neandertal DNA, a higher proportion of specific Neandertal DNA found in modern Europeans controls the metabolism of fat (Khrameeva et al. 2014). It is suggested that the greater efficiency of fat metabolism conferred upon Europeans by their Neandertal ancestors provided distinct benefits in the cold climate they encountered in Pleistocene Europe.

That's the good news. There also was a downside to the intrusion of Neandertal DNA into the modern genome. Neandertal genes appear to be associated with a number of human diseases, including lupus and Crohn's disease.

The Denisovan genetic contribution to the modern genome has been meaningful as well, for at least one population, the native people of Tibet. Most modern

Tibetans live at elevations exceeding 3,500 m (nearly 11,500 ft above sea level), where there is 40% less oxygen than at sea level (Qiu 2015). How do Tibetans survive in a region where most people would experience serious, even debilitating altitude sickness? In the spring of 2014, I hiked a couple of miles in the Bighorn Mountains of Wyoming, at an elevation just shy of 10,000 feet. I ended up feeling kind of crappy.

But Tibetans are fine at even higher elevations in part because they possess a genetic variation that adapts them to life in a high-altitude, low-oxygen environment. It turns out that the genetic variation that confers this advantage on Tibetans isn't present in any other modern human group but is replicated precisely in the Denisovan genome (Huerta-Sanchez et al. 2014). It seems probable that modern Tibetans obtained that genetic variation from their ancient ancestors who mated with the Denisovans.

Ultimately, we have all inherited a genetic legacy from the ancient hominins in the human bloodline. Some of it's good. Some of it's bad. But it's all in the family.

MESSAGES FROM THE PAST

HUMAN BEINGS: AN EVOLUTIONARY SUCCESS STORY?

Early in the story of the human family as presented in this book (Chapter 3), our ancestors were a rather unimpressive group living in a changing environment in a relatively restricted region in southern and eastern Africa. We were only one of a large number of ape and apelike species. We were not the biggest or the strongest, we were not the best climbers and not the best tree swingers. There's no evidence of great intelligence on the part of our ancestors, certainly nothing beyond that exhibited by other apes. There's no evidence of the use of fire or even much in the way of tools. In other words, none of the behaviors and abilities that define our species and about which we are so proud characterize these early evolutionary ancestors. The only thing that made them special appears to have been their ability to walk on two feet.

From these humble beginnings, we have seen so far in this book an increase in brain size and intellectual capability among our ancestors until that capability became our defining characteristic. That intelligence allowed us to adapt to changing conditions and to adjust our behaviors to meet the challenges of new environments into which our ancestors expanded (Chapter 4).

In this chapter we see further affirmation of this process resulting, ultimately, in the evolution of us. Our development of sophisticated tools, the controlled use of fire, our working cooperatively to accomplish necessary tasks, and our reliance on our brain power allowed us to spread our numbers onto every continent except Antarctica. The human domination of the planet we all see today is the culmination of this process.

In an apocryphal story, naturalist J. B. S. Haldane, when asked about any insights his science might provide about the mind of the Creator stated: "God has an inordinate fondness for beetles." That's what passes for high comedy in science; it's a sarcastic reference to the fact that there are literally hundreds of thousands of species of beetles so, if there's a God, he sure must like the little buggers.

I thought about that when I recently read an astonishing statistic; today, when you compile the sheer mass of the more than seven billion of us human beings altogether, we add up to eight times the biomass of all the other wild terrestrial vertebrates on Earth. Combined (Radford 2013). Wow! So, I guess it's fair, if someone were to ask what insights the study of evolution can provide, we might reasonably respond: "Evolution has an inordinate fondness for those upright walking creatures, the ones with very little fur and oversized heads."

Some might view this as a wonderful thing. Others might view the human race as analogous to an out-of-control cancer sucking up all of the resources of the planet, filling up the Earth and leaving very few resources, habitats, or even space for all of the other living things, at least the living things that we don't view as useful to us.

No matter your perspective, I think we can all agree on this point: Evolution has made us the most intelligent species on the planet. That intelligence has made us dominant, allowing us, as stated in Genesis in the Old Testament of the Hebrew and Christian Bible to "have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moves on the earth." But we are not apart from the planet, we are a part of it. Extinction, climate change, pollution, overpopulation, and war (my list is not exhaustive) are some of the less appealing aspects of human behavior made possible by our intelligence. It is long past time we might consider using that intelligence to respond to these challenging problems.

CASE STUDY CLOSE-UP

THE CAVES NEAR WHERE THE KLASIES RIVER empties into the Indian Ocean may have been first explored scientifically in 1923 during a survey of caves and rock shelters along the South African coast (Figure 5.25; Singer and Wymer 1982). The human remains recovered at Klasies River Mouth (KRM) have already been discussed in this chapter, so the focus here is on the stone-tool assemblage and the faunal remains.

An extensive array of stone tools was recovered at KRM. The vast majority of the tools were made from locally available beach cobble quartzite. Cobbles used by the cave's inhabitants to make tools were available virtually at the doorstep of the Klasies River Mouth caves.

The technology represented at KRM is, in the vernacular of African archaeology, a Middle Stone Age (MSA) industry, which means that it is essentially Mousterian in its technology. For the duration of the Late Middle Stone Age occupation of the caves, the inhabitants were removing flakes of various shapes and sizes from carefully prepared nodules of stone in a manner not unlike that of their European contemporaries.

Compared to European Mousterian industries, however, KRM technology exhibits a number of more finely made long flakes, called blades, with parallel or slightly subparallel (gently converging) sides (see Figure 5.24). Some blades with converging edges had been further flaked, after removal from their cores, into apparent spearpoints. Some of these tools seem, in a general way, to anticipate later, more advanced Late Stone Age industries in Africa and even the Aurignacian industry of the European Upper Paleolithic, to be discussed in Chapter 6. It is probably not coincidental that these more advanced-looking tools are found associated with modern-looking humans. Faunal analysis of the bone assemblage at KRM supports the notion that hunting played a major role in the inhabitants' subsistence. We know that the inhabitants of KRM and other Middle Stone Age sites in coastal South Africa were among the first people in the world to exploit aquatic resources, including shellfish, seals, penguins, fish, and sea birds (Klein 1977).

FIGURE 5.25
The area around the caves at Klasies River Mouth, South Africa. *(From* The Middle Stone Age at Klasies River Mouth, South Africa, *by Ronald Singer and John Wymer, University of Chicago Press, 1982)*

A detailed analysis by Richard G. Milo of the Klasies River Mouth faunal assemblage shows that the inhabitants were active hunters of large game animals (Bower 1997). About 20% of the 5,400 animal bones examined showed signs of butchery, often in areas that indicate the humans at Klasies were extracting prime cuts of meat, not just scavenging what carnivores had left behind (there are few signs of carnivores gnawing on the bones). Beyond this, a stone spearpoint was found embedded in the cervical vertebrae of a giant buffalo. Milo's analysis indicates that anatomically modern human beings were hunting in a behaviorally modern way by 100,000 years ago in South Africa.

SUMMARY

Beginning as much as 600,000 years ago, existing hominins gave way to more modern-looking hominin forms. With a mean cranial capacity exceeding 1,220 cc, the brain size of these premodern humans falls well within the modern human range. One sort of premodern human, the Neandertal, is the best known of these. Present in large numbers in Europe and southwest Asia, Neandertals were successful and intelligent hominins. There is evidence that they cared for their sick, buried their dead, and were the first human ancestor to produce art. The preponderance of evidence seems to indicate that the Neandertals were physically specialized to life in Ice Age Europe and represent an extinct side-branch of human evolution. Two different models have been proposed to explain the evolution from premodern to anatomically modern human beings. The replacement model maintains that anatomically modern people evolved just once from a population of premodern *Homo sapiens* living in Africa, sometime between close to 200,000 years ago. After 100,000 years ago, these first anatomically modern humans expanded beyond the boundaries of Africa, encountering and replacing indigenous groups of premodern *Homo sapiens* and even, possibly, *Homo erectus*, which had reached Europe and Asia during a previous period of hominin expansion out of Africa. The multiregional model proposes that anatomically modern humans evolved as a group

across all of Africa, Europe, and Asia, together and simultaneously. Gene flow resulting from mating was sufficient to move newly evolved modern traits throughout the many premodern populations but was not sufficient to swamp local physical features, which have been maintained into the present era as so-called racial characteristics. The data discussed in this chapter, consisting of skeletal evidence, artifacts, and genetics, seem to lend support to a "leaky replacement" model in which we owe most, but not all, of our genetic legacy to our African forebears.

Web links for this chapter can be found at www.oup.com/us/feder

TO LEARN MORE

Who the Neandertals were and what happened to them are mysteries that have captured the popular imagination. As a result, there is no shortage of popular articles and books focusing on these extinct members of the human lineage. Michael Balter's article in the October 9, 2009, issue of *Nature* provides a good summary of some of the complicated issues surrounding the nature of the relationship between the Neandertals and anatomically modern human beings. For an interesting book about the Neandertals, Thomas Wynn and Frederick Coolidge's *How to Think Like a Neandertal* (2011) is a great read. Two books that address the issue of how and why our anatomically modern human ancestors became the only extant variety of hominins are Christopher Stringer's *Lone Survivors: How We Came to Be the Only Humans on Earth* (2012) and Ian Tattersall's *Masters of the Planet: The Search for Human Origins* (2013). Take a look at the Special Evolution Issue of the September 2014 *Scientific American* (DiChristina, editor) for some very helpful and up-to-date articles and current perspectives on human evolution. Svante Pääbo is one of the leaders in the field of molecular archaeology, and his *Neanderthal Man: In Search of Lost Genomes* (2014) is an entertaining summary of his work, providing a useful discussion of the reconstruction of the Neandertal genome. For general discussions of how the recovery and analysis of DNA from ancient bones is revolutionizing the study of human evolution, take a look at a couple of articles in the July 24, 2015, issue of *Science*: Elizabeth Culotta's "New life for old bones" and Ann Gibbons's "Revolution in human evolution."

KEY TERMS

Aurignacian, 179
blade, 168
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