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Europe

Continental area with the longest, most nearly continuous record of primate (including human) evolution. Europe does not have the most ancient primates (as does North America), nor a good series of *Homo erectus* fossils and very early primates (as in Asia), and its fossil record lacks the broad representation of almost all primate groups and most major events in catarrhine and human history characteristic of Africa. What does distinguish Europe is that it has a good representation of both early and later primates and many human types and the longest history of the study of paleoanthropology and geology. As a consequence, the definitions of Cenozoic and most other time-scale subdivisions (epochs and stages), as well as of many types of lithic industries, technologies, and artifacts, are based on European type sections, especially from the Mediterranean and Paris-London basins and from southwestern France.

Europe is the smallest mainland continent, with an area of 10 million km^2, of which only the southern two-thirds is potentially habitable by nonhuman primates. Western Europe was faunally connected to North America but not to Asia in the Early Cenozoic; Africa was isolated; a seaway divided central Asia from most of eastern Europe. Asia and Europe were in contact by the mid-Cenozoic, and faunal interchange with Africa via western Asia became possible early in the Miocene. Late in that epoch, intermittent contact was probably feasible across the Mediterranean Basin, both in the center (ca. 11–9 Ma) and in the far west (ca. 6–5.3 Ma). At this time, the mainly forested environments present since

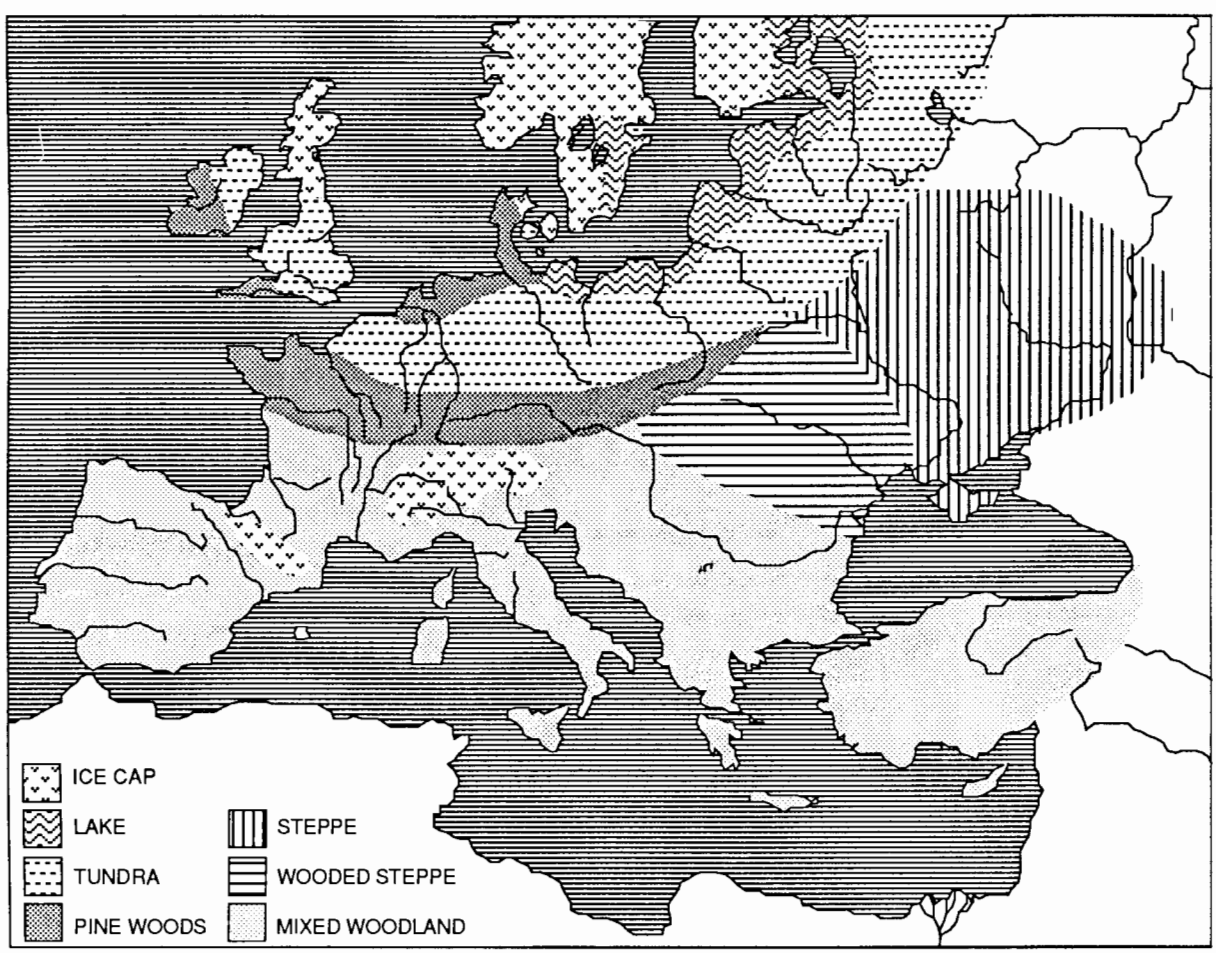
the Mesozoic were increasingly restricted northward, so that steppes dominated most of southern Europe from 8 to 5 Ma. The Mediterranean Basin became desiccated at the end of the Miocene as the result of tectonic contact with Africa in the west, preventing sufficient inflow of Atlantic water to keep the basin filled. After massive downcutting of river channels emptying into the basin (e.g., Rhone and Nile delta areas), a channel in the Rif area of Morocco refilled the Mediterranean with Atlantic water (and fossils), marking the beginning of the Pliocene ca. 5.2 Ma. Humid monsoon-type forest spread through southern Europe, but then global climatic cooling led to more open conditions in the later Pliocene and Early Pleistocene (ca. 3–1.0 Ma). A number of local mountain ranges that had risen mostly during the later Cenozoic were the centers of regional glaciation through the Pleistocene, as was the Scandinavian sector to the north. Latitudinal zonation of climatic belts typifies Europe today and probably did so through much of the Cenozoic.

Rise of Primates

Primates first appeared in the European fossil record in the Late Paleocene. *Plesiadapis* occurred in France at Cernay (and similar sites) and in Germany at the Walbeck fissure-fill, which also yielded the unique specimens of *Saxonella.* Plesiadapids continued into the Early Eocene in England, France, and Belgium (the important locality of Dormaal), alongside *Phenacolemur* and the first euprimates: the notharctid *Cantius* and the anaptomorphine omomyid *Teilhardina.* More than a dozen genera included in the Adapiformes ranged through the Eocene of Europe, from Portugal to England to northern Germany. The greatest number of localities are in southern France, especially the group of fissure-fillings and stratified sites in the Quercy region. Microchoerine omomyids coexisted with adapiforms at many, if not all, of the localities in the Middle and Late Eocene. In general, they were small, while adapiforms ranged in size from tiny to that of a cat, filling the niches taken by both notharctids and omomyids in North America. Just after the beginning of the Oligocene (34–33 Ma), a major faunal turnover known as the *Grande Coupure,* (Great Cutoff) took place, and all primates disappeared from the European fossil record throughout the rest of the Oligocene and Early Miocene.

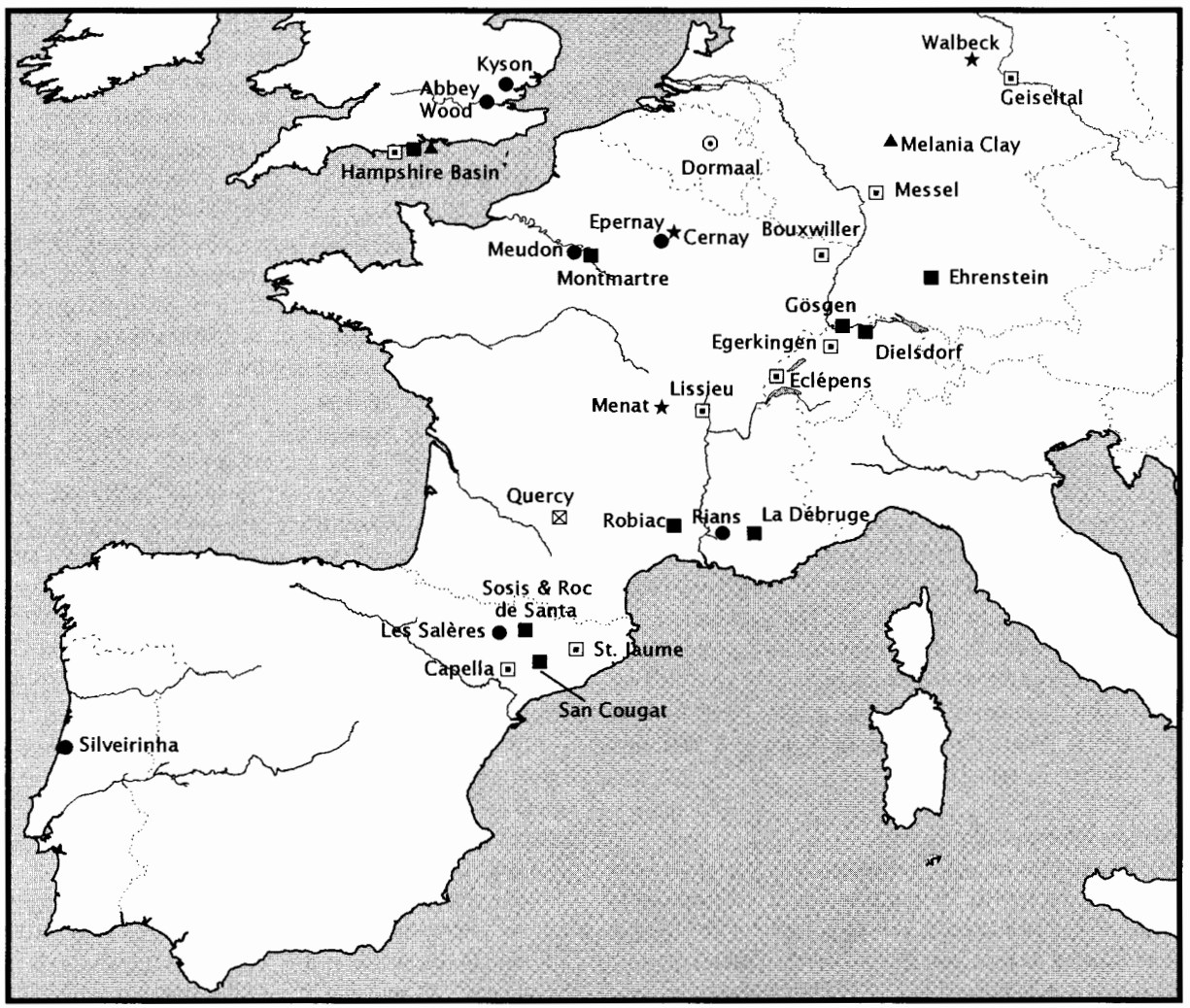
Only in the early Middle Miocene (ca. 17–16 Ma) do primates again appear in Europe, as a result of emigration from Africa. Pliopithecids were apparently the first to arrive, probably via the sub-Alpine route along the northern shore of the Mediterranean from western Asia. At this time, a major inland sea extended roughly east-west in the center of Europe and down to meet the Mediterranean in the Adriatic region.

Pliopithecus and allies were mainly restricted to the west and north of this seaway, from Spain through to Poland and Hungary (but also in Romania), between 16 and 11 Ma.



Topography and latitudinal floral zonation of Europe during a Pleistocene interstadial, slightly cooler than today.

Slightly younger is the first European hominid, *Griphopithecus*, known from a single tooth at Engelswies (Germany, ca. 15+ Ma) and a few others from Neudorf (Czech Republic, ca. 14 Ma); these appear to be closely similar to the large sample from Paşalar, Turkey. *Dryopithecus* arrived, or evolved locally, still later, perhaps by ca. 14 Ma, and sometimes occurred alongside the pliopithecids. At least three species are known from many localities: *D. fontani, D. laietanus,* and *D. ?brancoi,* and a fourth may occur in Spain; teeth from Udabno (Georgia, ca. 12 Ma) might represent *D. fontani* or a distinct species. Cranial and postcranial remains of *Dryopithecus* are known from the early Late Miocene of Can Llobateres (Spain, 9.6 Ma) and Rudábánya (Hungary, ca. 10 Ma), but opinions differ as to the affinities of this genus. It appears to have conservatively thin molar enamel and nearly gibbonlike nasopalatine morphology, the orbits are widely spaced, and its humerus and ulna display several features more like those of "modern" hominoids than is known for *Griphopithecus* or the African *Kenyapithecus.* Some authors have suggested that *Dryopithecus* may lie near the base of the oranguran (pongine) or African ape/human (hominine) clades, but it is probably more reasonably placed antecedent to that split, in the subfamily Dryopithecinae. Another member of that group may be the Italian "swamp ape" *Oreopithecus*, previously thought to be a cercopithecoid. More intensive studies have shown that, although it has distinctive



★ Middle-Late Paleocene – Plesiadapiformes
● Early Eocene – Plesiadapiformes, Adapidae
⊙ Early Eocene – Plesiadapiformes, Adapidae, Anaptomorphinae
⊡ Middle Eocene – Adapidae, Microchoerinae
■ Late Eocene – Adapidae, Microchoerinae
⊠ Early-Late Eocene – Adapidae, Microchoerinae
▲ Earliest Oligocene – Adapidae

Selected European Late Paleocene to Early Oligocene fossil primate localities. Age and included taxa are indicated according to the key at left:

teeth, which converge in some ways on those of ancestral Old World monkeys, its postcranium and some cranial features ally it with later Hominidae. Most specimens are known from a series of sites in Tuscany dated to 8–7 Ma; a few teeth are also known from Sardinia. One last hominid genus may also belong to the Dryopithecinae or, more likely, to the Homininae. *Graecopithecus* is represented by a partial skull and numerous jaws (but no postcrania) from Greek localities dated ca. 9.5–8 Ma. It shares some canine reduction with Hominini, and its molars have very thick enamel, but otherwise it is rather gorillalike in facial morphology, conforming to the morphotype for hominines; no derived characters are shared with Ponginae.

Cercopithecoids appeared in Europe in the Late Miocene, when *Mesopithecus pentelicus,* a semiterrestrial colobine, was common in the southeastern part of the continent at Pikermi and Saloniki (Greece), Titov Veles (Yugoslavia), Kalimanci (Bulgaria), and Grebeniki (Ukraine), all ca. 9–8 Ma. The range of this species continued eastward at least into Afghanistan. One premolar tooth from Wissberg, in the Eppelsheim-area "*Deinotherium*-Sands" of Germany, may date to 11 Ma.

With the aridification of southern Europe, ca. 6–5 Ma, all primates disappeared except a few poorly dated colobines known from forested localities in Hungary. The return of humid forests saw the spread of macaques (presumably from North Africa—two teeth are known in eastern Spain in the latest Miocene) and two new colobines: a smaller and more arboreal species of *Mesopithecus* and the moderately large-bodied, terrestrial *Dolichopithecus ruscinensis.* Between 5 and 3 Ma, these species are often found together at localities between Spain and Ukraine and as far north as Germany (Wölfersheim) and southern England (Red Crag). Later Pliocene and Pleistocene cooling probably led to the extinction of the colobines, but macaques indistinguishable from the living *M. sylvanus* of Gibraltar and North Africa persisted into the earlier Late Pleistocene across all of Europe from England and Spain to the Caucasus. The large-bodied, terrestrial, baboonlike *Paradolichopithecus* was apparently a local macaque derivative that converged on the savannah baboon niche. It is known from only a few sites in the later Pliocene of Spain, France, and Romania, and also from Tadzhikistan (central Asia).

Earliest Human Colonization

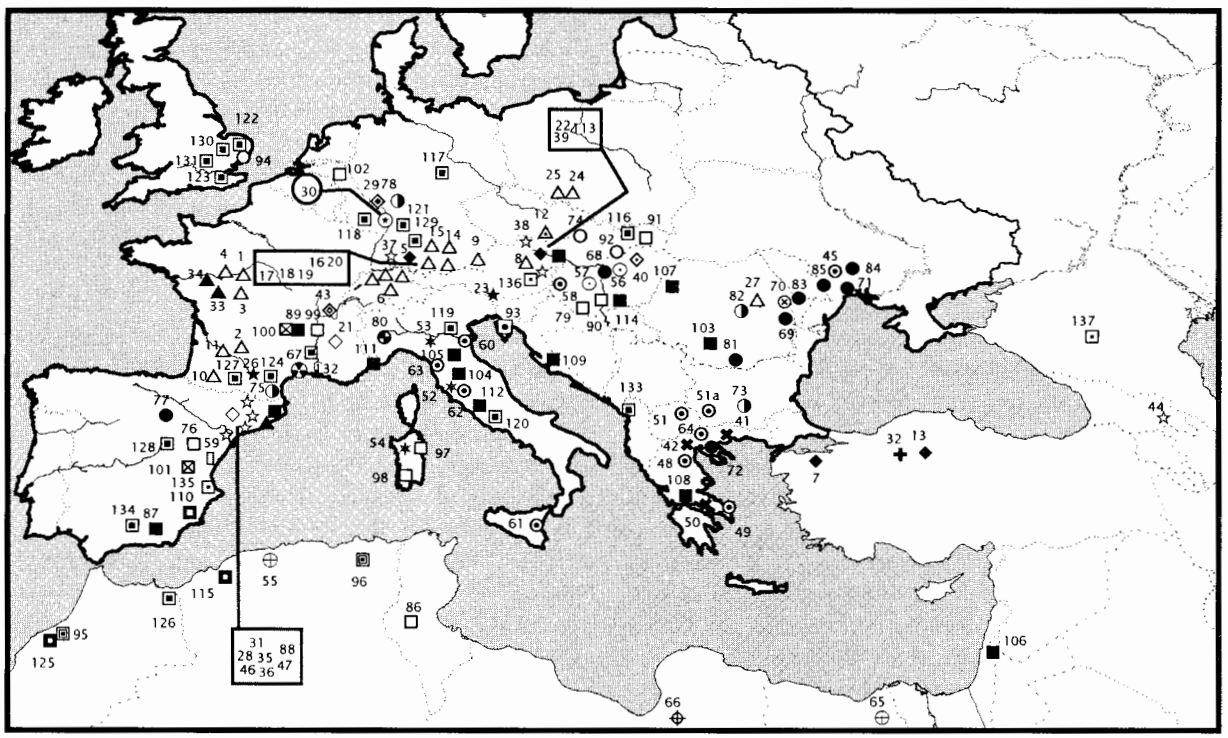
The date and nature of the earliest human occupation of Europe are controversial. Europe was clearly occupied over a wide area between 500 and 300 Ka, an interval discussed in the following section. A smaller number of sites have been suggested to date before 500 Ka, but most of these have been criticized on one or more grounds: the artifactual nature of the material (Chilhac, Kärlich, Nevers [Bourbonnais sands], Přezletice, St. Eble, Stranská Skála, Vallonnet, Venta Micena), the basis of the dating (Isernia), or the association between the dated material and the artifacts (Chilhac III, Monte Peglia, Monte Poggiole, Solheihac). In the past, many claims of Late Pliocene and Early Pleistocene sites were based on the argument that simple tools—pebble cores and minimally modified flakes—necessarily indicated great antiquity. Today, archaeologists recognize that such simple tools occur in assemblages of every prehistoric period and that hydrodynamic factors can, in some cases, mimic the appearance of human flintknapping. Accordingly, the acceptance of claims about early human sites in Europe (as in other regions) must depend heavily on biochronologic evidence and geochronometric determinations. In the early 1990s, such data only weakly supported any of the purported early occurrences.

Moreover, until the mid-1990s, indisputable human fossil remains were entirely lacking in Europe before ca. 500 Ka (or 600, if the oldest possible ages for the Mauer [Germany] mandible and Boxgrove [England] tibia are taken). In addition, unlike northern Africa and Asia, Europe lacked evidence for the presence of pre-"archaic *Homo sapiens*" populations, whether of *H. erectus* or another earlier species. In view of the clear documentation for much earlier human occupation in western (and eastern) Asia, as well as in northeast Africa ('Ain Hanech), the later occupation of Europe appeared to be due to an inability on the part of early humans to exploit temperate forested environments.

The discovery in 1991 of a human mandible at Dmanisi (Georgia) of probable *H. erectus* or *H. ergaster* affinities, in association with unspecialized (Mode 1) lithic artifacts lacking in bifaces, initiated a new period of inquiry into the timing of the earliest European occupations. The dating of this find is problematic, owing to its uncertain stratigraphic relationship to an underlying basalt dating to ca. 1.8 Ma, as well as to burrows containing fauna and sediments of reversed polarity that were excavated into the normally polarized sediment overlying the basalt. Thus, while the Dmanisi mandible is likely to be of Early Pleistocene age, its exact placement before 780 Ka is in some doubt. A date in the Matuyama Chron before the Jaramillo Subchron (ca. 1.4–1.1 Ma) seems most likely, given the associated fauna, the morphology of the fossil, and the dating of other finds from the region, such as 'Ubeidiya in Israel. Middle Pleistocene discoveries near the mountainous boundary between Europe and western Asia (e.g., Yarimburgaz in Turkey, Azych in Azerbaijan) confirm the early human ocupation of this general region.

At the other end of the European region, in the Gran Dolina Cave of the Sierra de Atapuerca (Burgos, Spain), Level TD-6 has yielded a series of more than 70 human fossil remains, also associated with an assemblage of more than 200 lithic artifacts, among which bifaces are absent. This occurrence has been dated by paleomagnetism as below the Brunhes-Matuyama boundary, but almost certainly above the Jaramillo event (ca. 1 Ma). Of particular importance is the presence of an Early Pleistocene chronostratigraphic marker in the microfauna from the site (*Mimomys savini*), which serves to confirm the early date. Similar fauna and tools have been recovered from a lower horizon (TD-4), which may approach the Jaramillo. Preliminary analyses of the human remains have led some to suggest that derived characters suggestive of affinities with the Neanderthal lineage are already present in the Gran Dolina sample.

Two other discoveries of simple flake artifacts in southern Spain (Orce region)—at Fontenueva and Barranco del



- Middle Miocene: Pliopithecidae
- Late Miocene: Pliopithecidae
- Middle Miocene: *Griphopithecus*
- Middle Miocene: *Dryopithecus*
- Late Miocene: *Dryopithecus*
- Late Miocene: *Dreopithecus*
- Late Miocene: *Ankarapithecus*
- Late Miocene: *Graecopithecus*
- Middle Miocene: Pliopithecidae & *Dryopithecus*
- Middle Miocene: Pliopithecidae & *Griphopithecus*
- Late Miocene: Pliopithecidae & *Dryopithecus*
- Late Miocene: ?Pliopithecidae & *Dryopithecus*
- Late Miocene: Pliopithecidae & *?Dryopithecus*
- Late Miocene: *Dryopithecus* & *?Mesopithecus*
- Late Miocene: *Macaca*
- Pliocene: *?Macaca*
- Pliocene: *Macaca*
- Early Pleistocene: *Macaca*
- Middle Pleistocene: *Macaca*
- Late Pleistocene: *Macaca*
- Pliocene: *Paradolichopithecus*
- Pliocene: *Macaca* & *Paradolichopithecus*
- Pliocene: *Theropithecus* (& *?Macaca?*)
- Early Pleistocene: *Theropithecus*
- Middle Pleistocene: *Theropithecus*
- Late Miocene: Macaca: Macaca & Colobinae
- ?Early Pliocene: Colobinae
- Pliocene: Macaca & Mesopithecus
- Late Miocene: *?Mesopithecus* (cf. *?Dolichopithecus*)
- Late Miocene: *Mesopithecus*
- Pliocene: *Mesopithecus*
- Pliocene: *Dolichopithecus*
- Pliocene: *Mesopithecus* & *Dolichopithecus*
- Pliocene: *Macaca*, *Mesopithecus* & *Dolichopithecus*
- Pliocene: *Paradolichopithecus*, *Mesopithecus* & *Dolichopithecus*

Map of Europe (heavy outline) showing major Middle Miocene to Late Pleistocene fossil localities with primates. Symbols indicate age and included primates, while numbers represent site names (in approximate chronological order), as follows: 1, Pontlevoy-Thenay; 2, La Condoue; 3, Manthelan; 4, Pontigné; 5, Engelswies; 6, Elgg; 7, Pasalar; 8, Göriach; 9, Trimmelkam; 10, Sansan; 11, Liet; 12, Neudorf; 13, Candir*; 14, Gallenbach; 15, Stätzling; 16, Ziemetshausen; 17, Stein Am Rhein; 18, Rümikon; 19, Kreuzlingen; 20, Diessen am Ammersee; 21, La Grive; 22, Klein Hadersdorf; 23, St. Stefan; 24, Opole; 25, Przeworno 2; 26, St. Gaudens; 27, Taut; 28, Castel de Barbera; 29, Eppelsheim; 30, Wissberg; 31, El Firal (Seu de Urgell); 32, Sinap Tepe*; 33, Doué la Fontaine; 34, Magné le Vicomte; 35, Can Ponsic; 36, Can Llobateres; 37, Swabian Jura sites; 38, Mariatal; 39, Götzendorf; 40, Rudabányá 20; 41, Nikiti-1; 42, Ravin de la Pluie, Xirochori-1; 43, Priay; 44, Udabno*; 45, Grebeniki-1; 46, La Tarumba 1; 47, Terrassa; 48, Ravin des Zouaves, Vathylakkos, Dytiko; 49, Pikermi; 50, Pyrgos; 51, Titov Veles; 51a, Kalimanci, Kromidovo; 52, Monte Bamboli, Baccinello V2, Montemassi, Casteani, Ribollo; 53, Serrazano; 54, Fiume Santo; 55, Menacer (Marceau)*; 56, Hatvan; 57, Polgardi; 58, Baltavar; 59, Casablanca-M; 60, Brisighella (Monticino); 61, Gravitelli; 62, Baccinello V3; 63, Casino; 64, Maramena; 65, Wadi Natrun*; 66, Sahabi*; 67, Montpellier; 68, Pest(szent)lörinc; 69, Beresti; 70, Malusteni; 71, Kuchurgan valley sites; 72, Megalo Emvolon; 73, Dorkovo; 74, Ivanovce; 75, Serrat d'en Vacquer; 76, Orrios 7; 77, Layna; 78, Wölfersheim; 79, Csarnota 2 & 3; 80, Fornace RDB; 81, Ciuperceni 2; 82, Baraolt-Capeni; 83, Budey; 84, Kotlovina; 85, Novopetrovka; 86, Ain Brimba*; 87, Moreda-1a; 88, Cova Bonica; 89, Vialette; 90, Beremend; 91, Vcelare 2; 92, Hajnacka; 93, Sandalja; 94, Red Crag; 95, Ahl Al Oughlam*; 96, Ain Jourdel*; 97, Capo Figari; 98, Is Oreris; 99, St. Vallier; 100, Senèze; 101, Puebla de Valverde; 102, Tegelen; 103, Graunceanu; 104, Valdarno; 105, Mugello; 106, 'Ubeidiya*; 107, Betfia; 108, Tourkoubounja 2; 109, Razvodje; 110, Cueva Victoria; 111, Vallonet; 112, Monte Peglia; 113, Deutsch-Altenburg; 114, Somssichhegy 2; 115, Tighenif*; 116, Gombasek, Zlaty Kun; 117, Voigtstedt; 118, Hohensülzen; 119, Zoppega II; 120, Ranuccio; 121, Mosbach-2; 122, Cromer; 123, Swanscombe; 124, St. Estève; 125, Thomas Quarry III*; 126, Ain Mefta*; 127, Montsaunès; 128, Ambrona; 129, Heppenloch; 130, Hoxne; 131, Grays Thurrock; 132, Orgnac; 133, Gajtan; 134, Solana de Zamborino; 135, Cova Negra; 136, Kugelsteinhöhle; 137, Kudaro*. * indicates locality outside geographic area, but included for comparison. The site numbers enclosed in boxes correspond to unnumbered symbols.*

Leon—have been similarly dated by paleomagnetic analysis to before the Brunhes-Matuyama boundary, possibly before the Jaramillo. A third Orce-region Early Pleistocene site, Venta Micena, has yielded some stone artifacts and a skull fragment described as hominid; this designation has been widely disputed.

Between the eastern and western extremities of Europe, the best evidence for human occupation pre-500 Ka derives from Italy. From the Po Valley to the southern region of Molise, a number of sites have suggested early occupation of this region. The evidence from the northern cave sites of Monte Peglia and Monte Poggiole is controversial, as the association between artifacts and dates is uncertain. In the south and center, however, three open-air sites are definitely indicative of pre-500 Ka occupation in association with fluvio-lacustrine systems. The best known of these is Isernia-La Pineta, a multiple-horizon site in alternating fine-grained sediments and fluvial gravels. The archaeological levels were dated older than 730 Ka, but some dated material may be reworked volcanic crystals. The artifacts are surely older than an overlying layer dated to 500 Ka, but they could be close to that age, which would still make them significant. Artifacts were made primarily on flint and by the predominant use of the bipolar technique; refitting suggests that at least some of the material is in primary context. Some flakes may have been utilized in butchery activities, possibly related to the large herbivore skeletons (rhinoceros, bison, and elephant) found at Isernia.

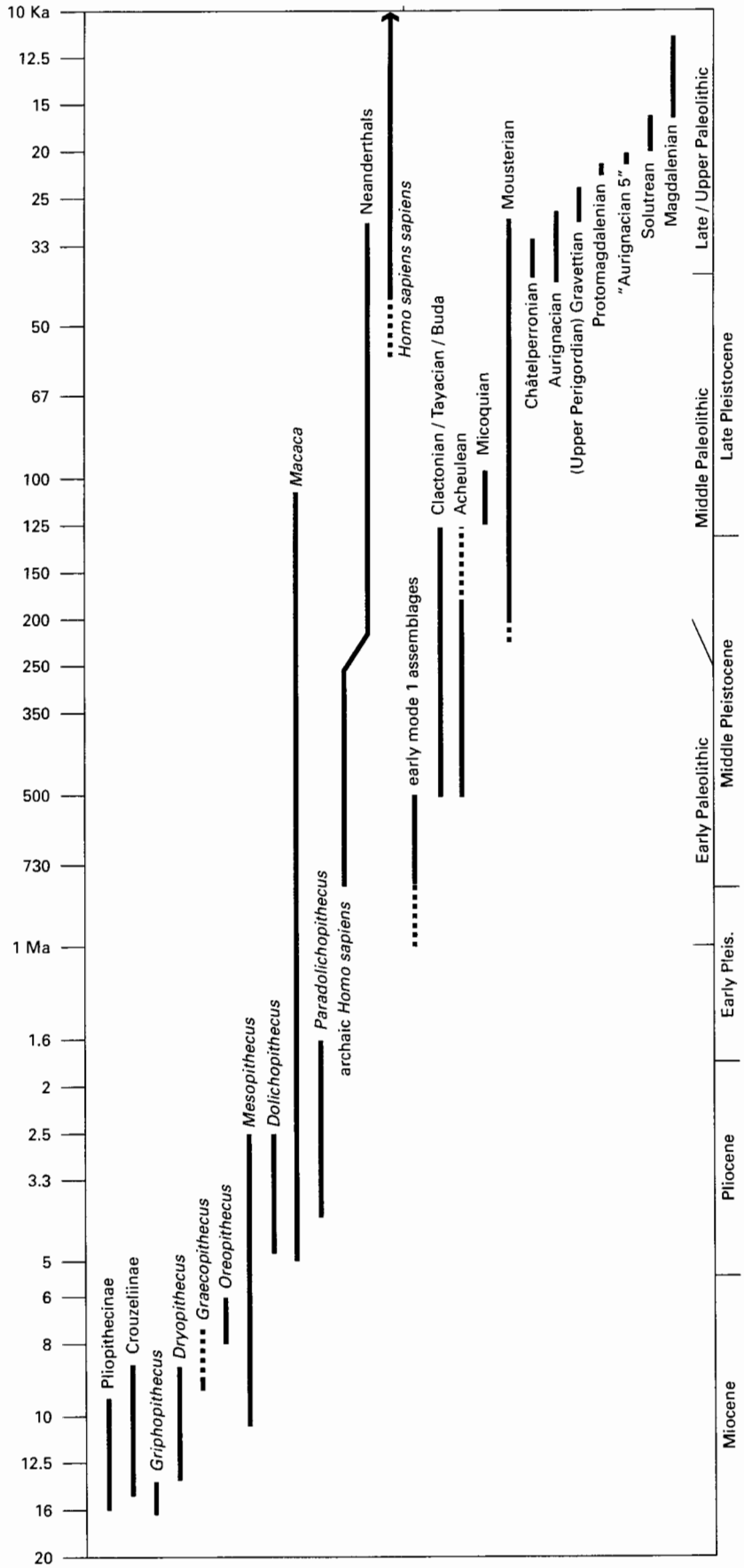
Another locality in southern Italy, Notarchirico, in the Venosa group, is a similar multi-horizon open-air site in fluvio-lacustrine sedimentary contexts with associated volcanic tuffs and a large herbivore fauna. In the case of Notarchirico, however, the tuff overlying the oldest horizons is in primary context and appears to date to ca. 650 Ka by TL (thermoluminescence) and tephrostratigraphy in relation to a regional volcanic sequence. The artifacts in these basal horizons include several bifaces, which are the oldest such tools in a securely dated context in Europe. A human femoral shaft is comparable to those of *H. erectus* and presumably to the poorly known "archaic *Homo sapiens*" postcranium.

Finally, in central Italy (south of Rome), similar deposits at Ceprano have yielded a well-preserved human calvaria and stone tools. An Early Acheulean horizon with bone tools is correlated to the ca. 450 Ka level at nearby Ranuccio, which has produced two human incisors. The Ceprano calvaria derives from a lower, otherwise sterile layer that is correlated to a local 700 Ka basalt. It has been termed "late *Homo erectus*" but seems better interpreted as "archaic *Homo sapiens*" (= *H. heidelbergensis*). Still lower in the sequence is a level with fauna and Mode 1 artifacts, from which the skull may have been ultimately derived. An age of 800 Ka has been suggested for the lowest horizon.

Thus, the oldest human occupation in Europe now appears to date to at least 1.1 Ma and to be characterized by human populations initially (in the east) of *H. erectus* type but later (by ca. 800 Ka) by populations with some derived "archaic *Homo sapiens*," if not Neanderthal, features. Associated simple flake industries almost always lack bifaces. This evidence is found across the southern third of the European landmass but is absent from more northerly areas. Before 500 Ka, bifaces also appear but are not numerous. It is possible that this early occupation was intermittent rather than continuous. The area of origin of the first Europeans is unknown. The distribution of sites in the Levant, the Caucasus, Italy, and Spain suggests that any one or more of four routes (trans-Bosphorus, trans-Caucasian, trans-Sicilian, or trans-Gibraltar) might have been possible, although in descending order of likelihood.

Why is there so little clear-cut evidence for an Early Pleistocene human presence in Europe? The scarcity of Early Pleistocene sites from Europe at first seems especially puzzling when compared to the record for Asia, but, in fact, the differences are not so striking. Fragmentary hominin remains are associated with both Developed Oldowan and Early Acheulean assemblages and a temperate Eurasian faunal assemblage at 'Ubeidiya at ca. 1.4 Ma, and human remains with Mode 1 tools from Dmanisi date only slightly younger. In eastern Asia, human fossils unaccompanied by artifacts in Java surely predate 1.0 Ma and may extend back toward 1.8 Ma, but the associations between fossils and dates are still in question; only Sangiran in Java has yielded more than one or two specimens older than ca. 750 Ka. In China, both the date and the identity of the putative 1.8 Ma Longgupo fragments (and scant artifacts) are questioned, and the two teeth from Yuanmou may well date to less than 600 Ka. The Lantian Gongwangling fragmentary cranium is clearly *H. erectus*, and, although it is surely older than 780 Ka, it may not be over 1.1 Ma as claimed. Similarly, archaeological residues without human remains from Nihewan are probably close to 1.0 Ma, but other claimed sites of similar antiquity in China (e.g., Xihoudu) are questionable. Given the rough comparability in temperate area between China and Europe, the number and quality of sites are extremely similar. Only tropical Java has produced more, and that is basically the bonanza of Sangiran. All of this evidence pales in comparison to Africa, but even there, the 1.3–0.6 Ma interval is low in human fossils although well stocked with Acheulean sites (as is western Asia after 1.0 Ma).

Thus, there are really two related questions: Why are all signs of human occupation so scarce? And why are bifaces rare in Europe before 300 Ka when they were so common in Africa? One possibility is that colonization was limited by climate. In this model, the Levant and adjacent parts of western Asia were colonized intermittently from Africa during periods of more open, savannah-like conditions, much like those to which hominins had adapted in the African tropics. Europe, on the other hand, was characterized from the Pliocene onward by relatively long, cloudy winters and a short growing season, adaptive constraints quite different from those of the subtropics. (Regions of China apparently colonized by humans by at least 1.0 Ma are south of 40° N latitude; almost all of Europe is north of this line, excepting only Sicily, southern Sardinia, southern Greece, and parts of Iberia). From the Late Pliocene to the early Middle Pleistocene, glacial cycles lasted ca. 40 Kyr, with slow cooling and warming phases. After ca. 900 Ka, the cycles spanned ca. 100 Kyr and were characterized by long cooling trends of higher amplitude, followed by rapid warming and short interglacial



Time ranges of European primate (including human) taxa and archaeological industries. Note: time scale is logarithmic.

intervals. (Warm phases seem to have lasted only 10–20 Kyr from 2.5 Ma onward.)

There are no clear signs of a major shift in the African archaeological record accompanying the transition to longer and higher-magnitude glacial cycles after 0.9 Ma, as one would expect if climate were the sole limiting factor on hominin settlement. However, as noted, the African record is poor from 1.3–0.9 Ma. The greater number of Eurasian sites after this time is *a* signal, but it appears counterintuitive to have *more* humans when the climate is harsher, unless the humans themselves had changed in the interim. It is tempting to suggest that "archaic *Homo sapiens*" was the result of such a change, whether it originated in Africa or western Eurasia.

A related possibility is that colonization of Europe may have required both reliable hunting to survive the longer winters and effective control of fire. Early African *H. erectus* may have obtained animal protein primarily through scavenging, rather than hunting. Controlled fire has been documented in both eastern and southern Africa from ca. 1.6–1.3 Ma onward, but it is rare there, and apparently undocumented in the pre-0.5 Ma record of Europe, so it may not yet have been fully controlled. C. Gamble suggested in 1994 that the delay in colonizing Europe was due to the poor resource base during the winter, which required foragers to cover more ground in smaller groups; this, in turn, required an intensification of social life or, more specifically, of the mental construction of a social life among individuals who were not always present in a face-to-face relationship. Social memory and planning among primates is a major component of primate intelligence and may be indirectly reflected in increasing brain size.

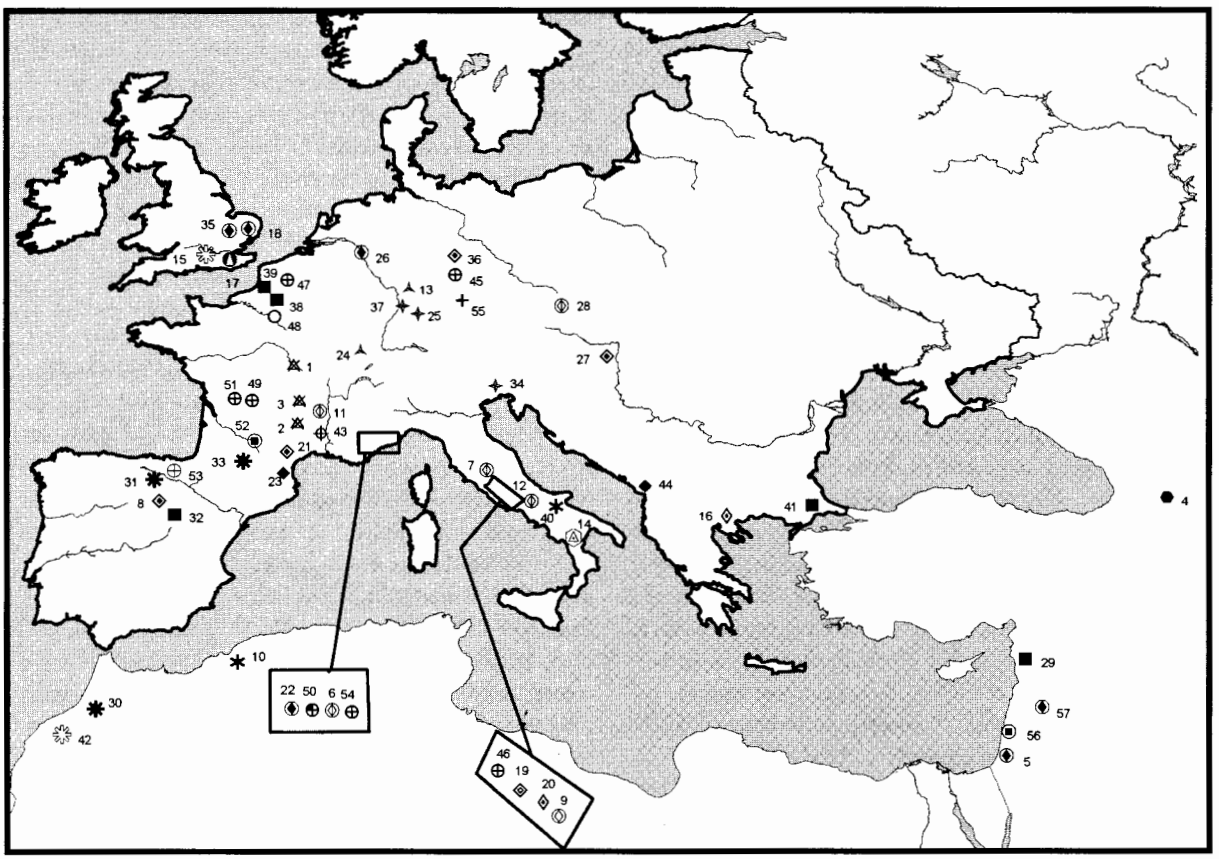
It seems likely that humans did occupy Europe during the Early Pleistocene, but only intermittently and in small numbers, leaving behind only short-term use and expedient tool kits. Why didn't these tool kits contain bifaces? If bifaces served a raw-material-storage function in Africa and in western Asia, the population densities of Europe may have been too low to support this type of reoccupation and reuse strategy. Analogous situations occur in the Early Paleolithic of eastern Asia (east of Movius' line) and the earliest Paleoindian occupation of the Americas. In Asia, it has been suggested that Mode 1 stone tools were used to make more specialized tools from bamboo or that humans arrived there before the Acheulean was "invented" in Africa. In the Americas, putative pre-Clovis tool kits without finely worked fluted points are usually dismissed as poorly dated or of natural origin, but in all three areas it has been suggested that the earliest occupants either lost knapping skills on the trail or had not yet discovered sources of possibly different raw materials than they had been used to using. As always, more data are required to test these hypotheses, but into the late 1990s such data were available in Europe only after 500 Ka.

Archaic *Homo sapiens* and the Acheulean: The Later Middle Pleistocene

The evidence for a hominin presence in Europe is substantially better for the period 0.5–0.25 Ma, and few researchers dispute the validity or the antiquity of the numerous archaeological and paleontological sites assigned to this period. Sites yielding substantial archaeological remains from this period include Arago, Barbas, Terra Amata, and the Somme River Gravels near Abbeville and St. Acheul in France; Bilzingsleben and Kärlich in Germany; Vértesszöllös in Hungary (perhaps younger than the others); Atapuerca, Torralba, and Ambrona in Spain; and Boxgrove, Clacton-on-Sea, Hoxne, and Swanscombe in southern England. Of these, all except Arago and Atapuerca are stream-channel or lakeshore–beach deposit sites, reflecting the relative predominance of such localities in the archaeological record of this period. The archaeological remains from these sites are broadly comparable to those found in Africa and western Asia during the same (and earlier) periods. In general, there are two kinds of lithic associations: Acheulean assemblages, which include large bifacially flaked core tools; and other assemblages lacking bifaces and composed primarily of pebble cores, retouched-flake tools, and pounding tools. The latter assemblages are known by many regional names (e.g., Tayacian, Evenosian, Buda industry, Clactonian) and differ from one another in few ways other than in the raw materials utilized and the relative frequencies of certain tool types, such as single-blow notched pieces (Clactonian) or crudely shaped points (Tayacian). All are broadly comparable to the Developed Oldowan industries from African Early and Middle Pleistocene sites. While it is difficult to unite these European industries with the broadly contemporaneous Acheulean, from which they differ technologically, there is little reason to suppose they represent the activities of distinct hominin populations. It seems far more reasonable to attribute the differences to situational variables, such as the local raw materials or the kinds of activities being performed, or to drift in the tool-making traditions of various hominin groups.

Some Middle Pleistocene sites, such as Torralba and Ambrona, feature residues of human activity in close association with large-mammal skeletal remains (elephant and horse, in the case of Torralba and Ambrona). Recent studies suggest that many such sites, traditionally seen as kill sites, may instead reflect hominin scavenging of natural death-sites, such as the edges of lakes or seasonal ponds. Circular patches of ash and carbonized bone at several sites, such as Terra Amata and Vértesszöllös, point to human control of fire, which would have been essential for survival through European winters. At least two sites, Terra Amata and Bilzingsleben, contain strong evidence for the manufacture of artificial shelters—in these cases, probably huts or windbreaks. Apart from typological similarities between lithic assemblages, which may reflect little more than the technological simplicity of those industries, there is little evidence of long-distance transport of raw materials or long-distance cultural connections among hominin groups living in Europe during this time. In this respect, the European record differs little from that seen in Africa and Asia during Middle Pleistocene times.

Sites with human fossil remains dating to this period are known throughout mid-latitude and southern Europe, with the exception of the Black Sea region. Some of the most notable Middle Pleistocene hominin fossil sites include Atapuerca (Spain); Arago and perhaps Montmaurin (France); Swanscombe and Boxgrove (England); Bilzingsleben, Stein-



- ?Mode 1 ("geofacts"?)
- *Homo erectus* & Mode 1
- Early "archaic *Homo sapiens*"
- Late "archaic *Homo sapiens*"
- Early Neanderthal
- ?Early "archaic *H. sapiens*" & ?Mode 1
- Early "archaic *H. sapiens*" & Mode 1?
- Mode 1 tools
- Early "archaic *H. sapiens*" & Mode 1
- ?Mode 1 tools
- Acheulean
- Early "archaic *H. sapiens*" & Acheulean
- Late "archaic *H. sapiens*" & Acheulean
- ?Early "archaic *H. sapiens*" & Acheulean
- ?Early "archaic *H. sapiens*" & Mode 1 & Acheulean
- Mode 1 & Acheulean
- Early "archaic *H. sapiens*" & Mode 1 & Acheulean
- Late "archaic *H. sapiens*" & Mode 1 & Acheulean
- Early Neanderthal & Acheulean & Early Mousterian
- Early Mousterian
- ?Early Neanderthal & Early Mousterian
- Early Neanderthal & Early Mousterian
- ?Early Neanderthal & ?Early Mousterian
- Acheulean & Early Mousterian
- Early "archaic *H. sapiens*" & Mode 1 & Acheulean & ?Early Mousterian

Map of Europe (heavy outline) showing major localities with hominin fossils and archaeological inventories older than Late Pleistocene (>130 Ka). Symbols indicate age, taxon and cultural allocation, while numbers represent site names (in approximate chronological order), as follows: 1, Bourbonnais; 2, Saint Eble; 3, Chilhac; 4, Dmanisi; 5, 'Ubeidiya*; 6, Vallonet; 7, Monte Peglia; 8, Atapuerca TD6; 9, Ceprano; 10, Tighenif*; 11, Soleilhac; 12, Isernia; 13, Mauer; 14, Venosa sites; 15, Box Grove; 16, Petralona; 17, Swanscombe; 18, Clacton; 19, Ranuccio; 20, Pofi; 21, Arago; 22, Terra Amata; 23, St. Estève; 24, Vergranne; 25, Steinheim; 26, Kärlich; 27, Vértesszöllös; 28, Stranská Skala; 29, Latamne*; 30, Salé*; 31, Atapuerca Sima; 32, Torralba & Ambrona; 33, Montmaurin; 34, Visogliano; 35, Hoxne; 36, Bilzingsleben; 37, Reilingen; 38, Saint Acheul; 39, Abbeville; 40, Altamura; 41, Yarimburgaz; 42, Thomas Quarries*; 43, Orgnac; 44, Gajtan 1; 45, Ehringsdorf; 46, Castel di Guido, Monte delle Gioie, Ponte Mammolo and Rebibbia—Casal de Pazzi; 47, Biache; 48, Levallois; 49, La Chaise; 50, Lazaret; 51, Fontéchevade; 52, Pech de l'Azé; 53, Lezetxiki; 54, Grimaldi (Grotte du Prince); 55, Hunas; 56, Tabun*; 57, Jabrud*. * indicates locality outside geographic area, but included for comparison.*

heim, Mauer, and perhaps Reilingen (Germany); Vértesszöllös (Hungary); and Petralona (Greece). The taxonomy of these fossils is highly controversial: Although some specimens have been attributed to *H. erectus*, most authors refer to them as "archaic *Homo sapiens*" or, more recently, *H. heidelbergensis* (originally coined by Schoetensack in 1908 for the Mauer mandible). Many, if not all, specimens exhibit a mosaic pattern of primitive features undoubtedly reflecting their *H. erectus* ancestry mixed with derived characteristics resulting from a combination of genetic drift and natural selection for morphological adaptations, perhaps to colder climates. The range of estimated cranial capacities overlaps the mean of the later *H. erectus* sample from Asia but may average somewhat higher. Some fossils (e.g., Bilzingsleben) exhibit the typical angulated occipital region of *H. erectus*, while others (Petralona, Atapuerca, Steinheim, Swanscombe, Vértesszöllös) have a more rounded occipital region and a reduced and more inferiorly directed occipital torus. Similarly, the faces of Petralona, Atapuerca, Steinheim, and Arago are quite pneumatized and exhibit both midfacial prognathism and the divided superciliary arches of the later Neanderthals, while retaining some primitive features not found in the latter group. In the presence of characteristics shared with later Neanderthals, the Middle Pleistocene Europeans differed from their African contemporaries. There can be little doubt that the wide swings of the climatic pendulum during this period led to the isolation of many European populations and, consequently, to morphological divergence due to small groups breeding in comparative isolation. (This same hypothesis could also be applied to Africa and eastern Asia, where the periodic expansion of deserts and tropical rain forests would have been formidable isolating mechanisms.)

Hominin fossils dating to 0.25–0.13 Ma exhibit additional morphological characteristics suggesting close association with the distinctive Weichselian (last glacial) West Eurasian Neanderthals. Among the most important remains are those from Ehringsdorf (Germany); Pontnewydd (Britain); and Lazaret, Biache-St. Vaast, La Chaise, and Fontéchevade (France). Some scholars term this group *early Neanderthals,* emphasizing both their connections to, and their differences from, the later, or *classic,* Neanderthals. Others consider them late archaics (or *pre-Neanderthals*), little different from their predecessors, while another school hardly distinguishes them from the "classics." If a formal taxonomic distinction is drawn between *H. heidelbergensis* and *H. neanderthalensis*, it is the "early Neanderthals" that most often fall into limbo. On the other hand, under a model of the accretion of derived Neanderthal characteristics over time in the European human lineage, this group fits well with their beginnings of the occipital bun and suprainiac fossa, taurodontism, and other features, as discussed by D. Dean and colleagues in 1998.

Shifts in the accompanying lithic industries for this period include the development of prepared-core (Levallois) techniques and an increasing number of Acheulean bifaces exhibiting secondary thinning and careful shaping seemingly beyond the minimum amount necessary to produce a functioning cutting edge. A tendency for more controlled shaping of retouched-flake tools has also been noted, and assemblages with few handaxes and many such shaped flake tools are often termed *Premousterian* or *Early Mousterian,* blurring the traditional typological distinction between the European Early and Middle Paleolithic. Instead, there seems to have been a transition interval, with both Mousterian and Acheulean-like assemblages being manufactured between ca. 200 and 150 Ka, after which the Mousterian was dominant (although the Micoquian of the earlier Late Pleistocene represented a continuation of Early Paleolithic styles and forms). This pattern and timing is rather similar to that seen in Africa, where the Middle Stone Age (MSA) also began ca. 200 Ka and may have briefly overlapped the final Acheulean.

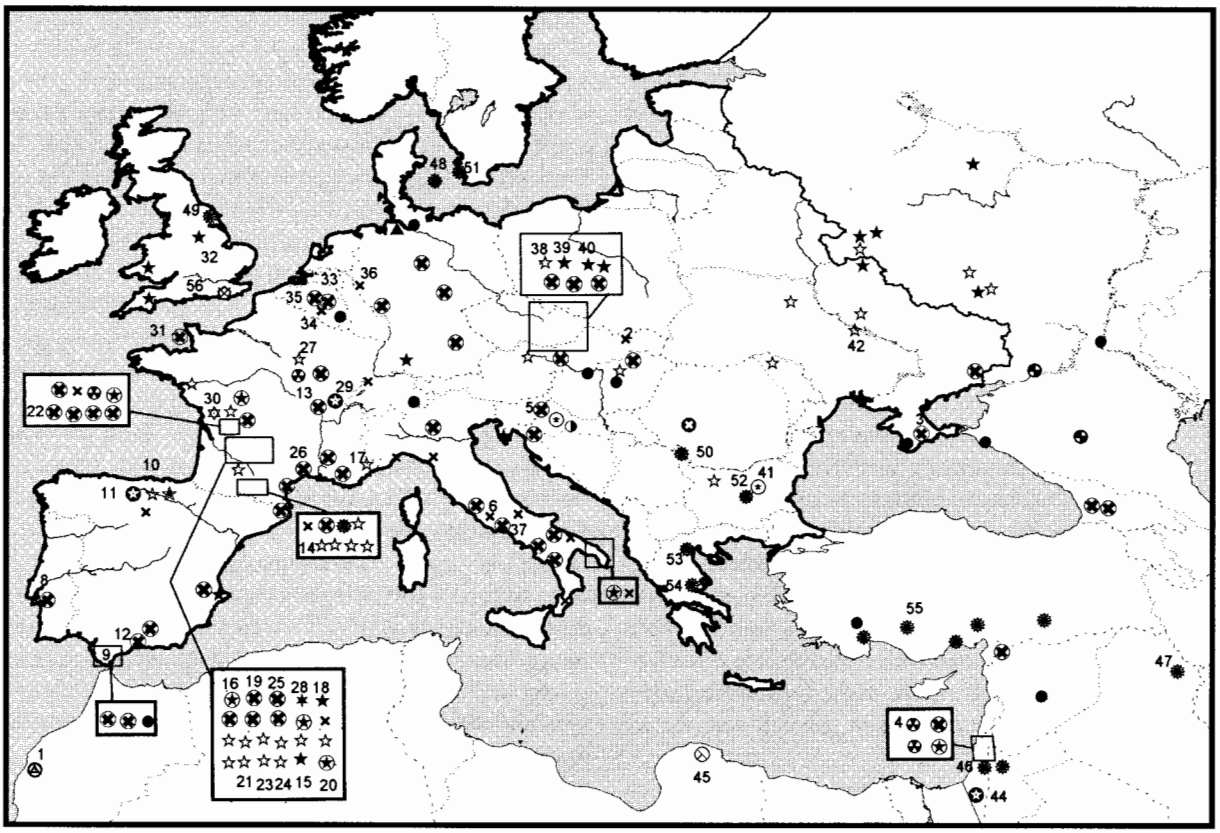
Additional evidence for the construction of simple shelters (Lazaret, Ariendorf) and somewhat more convincing evidence for technologically assisted hunting of large mammals (Lehringen, La Cotte de St. Brelade) date to the period 250–130 Ka. On the whole, however, the archaeological evidence for the final Middle Pleistocene differs little from that from 500–250 Ka. The difficulties of precisely dating a relatively patchy European archaeological and paleontological record make it difficult to adequately evaluate models proposing either long-term regional continuity or, alternatively, repeated cycles of colonization and extinction or population bottlenecking among Middle Pleistocene European hominins. Inasmuch as there is scarce evidence for hominin activities in boreal forests or tundra, however, it seems reasonable to suppose that Middle Pleistocene climatic fluctuations caused significant shifts in the distribution and demographic structure of hominin populations.

The Middle Paleolithic and the Classic Neanderthals

Traditionally, European prehistorians have distinguished a Middle Paleolithic (ca. 110–35 Ka) from the preceding Early Paleolithic on the basis of declining frequencies of large Acheulean core tools, increasing use of prepared-core techniques, increasing numbers of retouched-flake tools, more numerous cave occupations, and the evolution of distinctive Neanderthal populations. As noted above, however, there are essential continuities in all of these areas between the Middle Paleolithic and its Acheulean and Premousterian predecessors. Because of this, many scholars now recognize the Early/Middle Paleolithic distinction to be somewhat arbitrary, at least in Europe.

During the Eemian interglacial (ca. 130–115 Ka), Neanderthals appear to have spread widely across Europe and into Southwest Asia, with representative European sites including Saccopastore (Italy), Krapina (Croatia), and Gánovce (Czech Republic). Fewer sites of this age are known, in part because of the interglacial scouring of caves due to an increase in glacial meltwater and precipitation and in part because of the lack of sedimentation, whether of cold-fractured detritus in rockshelters or of wind-blown loess in open-air sites.

During much of the last or Weichselian glaciation (ca. 115–30 Ka), Neanderthals were the only hominids in Europe. They exhibit a number of derived morphological characteristics, including pronounced mid-facial prognathism and a heavily pneumatized face; robust, doubly arched



- Acheulean & ?Early Mousterian
- Late Neanderthal & Mousterian (& sometimes Acheulean)
- Late Neanderthal & ?Mousterian
- Late Neanderthal
- Mousterian
- early? *H. s. sapiens* & Mousterian
- "Pre-Aurignacian" & early? *H. s. sapiens* & Mousterian & Upper Paleolithic
- Late Neanderthal & (?) Mousterian & Upper Paleolithic
- ?Late Neanderthal & Mousterian & (?) Upper Paleolithic
- Late Neanderthal & *H. s. sapiens* & Mousterian & Upper Paleolithic
- *H. s. sapiens* & Mousterian & Upper Paleolithic
- Mousterian & Upper Paleolithic
- Late Neanderthal & Chatelperronian
- Chatelperronian & Aurignacian
- *Homo sapiens sapiens*
- Upper Paleolithic
- *H. s. sapiens* & Upper Paleolithic
- *H. s. sapiens* "wraith" & Upper Paleolithic
- Post Paleolithic (Epipaleolithic, Mesolithic, Neolithic)
- Piltdown forgery

Map of Europe (heavy outline) showing major localities with hominid fossils and archaeological inventories younger than Middle Pleistocene (<130 Ka). Symbols indicate age, taxon and cultural allocation, while numbers represent site names (grouped in approximate chronological order—older than 90 Ka, 90–10 Ka, and younger than 10 Ka, mostly from west to east). All important sites shown as symbols, but only a selection is numbered and identified, as follows: 1, Jebel Irhoud; 2, Gánovce; 3, Kiik-Koba; 4, Mount Carmel (Skhul, el-Wad)*; 5, Krapina; 6, Saccopastore; 7, Bañolas; 8, Figueira Brava; 9, Forbes Quarry; 10, Altamira; 11, Castillo; 12, Zafarraya; 13, Arcy sur Cure; 14, Aurignac; 15, Combe-Capelle; 16, Combe-Grenal; 17, Cosquer; 18, Cro-Magnon; 19, La Chapelle aux Saints; 20, La Ferrassie; 21, La Madeleine; 22, La Quina; 23, Lascaux; 24, Laugerie Haute; 25, Le Moustier; 26, L'Hortus; 27, Pincevent; 28, Roc de Combe & Le Piage; 29, Solutré; 30, St.-Césaire; 31, Cotte-de-St.- Brelade; 32, Mother Grundy's Parlour; 33, Engis; 34, La Naulette; 35, Spy; 36, Neandertal; 37, Monte Circeo; 38, Dolni Vestonice; 39, Mladec; 40, Predmosti; 41, Bacho Kiro; 42, Mezhirich; 43, Sungir*; 44, Boker Tachtit*; 46, Jericho*; 47, Jarmo*; 48, Maglemose; 49, Star Carr; 50, Lepenski Vir; 51, Vedbaek; 52, Karanovo; 53, Nea Nikomedia; 54, Sesklo; 55, Catal Hüyük*; 56, Piltdown. * indicates locality outside geographic area, but included for comparison. Note that (?) in symbol key indicates an industry usually present at these sites but possibly questionable at some. Numbers in boxes refer to neighboring symbols; not all boxed symbols are identified by number.*

supraorbital torus; large nasal cavity with medial projections; a long, low cranial vault with lambdoidal flattening; occipital bunning and a suprainiac fossa; and a juxtamastoid crest larger than the mastoid process. Molar teeth have enlarged pulp cavities and partially divided roots (a condition known as taurodontism), and these teeth are placed forward of the ramus, creating a retromolar gap. Many Neanderthals also exhibit extreme linguo-labial paramasticatory wear on their anterior dentition, suggesting that these teeth were habitually used as a "third hand" in object manipulation. Postcranially, the hypertrophy of Neanderthal skeletons provides numerous indications of extreme strength, such as enlarged articular surfaces and relatively large cortical bone segments. As one would expect for hominins repeatedly stressed by cold conditions, Neanderthals have relatively shorter distal limbs than do contemporaneous populations from warmer climates, such as the early modern humans from Skhūl and Qafzeh in the Levant. Western or classic, Neanderthals were somewhat more derived than eastern European and Southwest Asian varieties, which seem to have changed little from the interglacial populations. This is presumably a result of greater adaptation to cold climate in the west, where the Neanderthals were closer to the harsh climates near the ice front.

There is intense argument about the phyletic position and taxonomy of the Neanderthals. Some authors consider them a distinctive temporal subspecies, *Homo sapiens neanderthalensis*, extending back to 130 Ka, 200+ Ka (the earliest Mousterian), or beyond (Atapuerca, Steinheim, even Petralona and Arago). This view is compatible with either the concept of Neanderthals as a long-separated lineage that was replaced by anatomically modern humans with little, if any, interbreeding, or the view that anatomically modern Europeans were descended, at least in part, from some Neanderthal population. An alternative taxonomy recognizes the species *Homo neanderthalensis* for some or all of the European lineage, perhaps separating this species at some point in time (and morphology) from an earlier *H. heidelbergensis*. Proponents of this view all see the Neanderthals as an evolutionary dead-end.

In either case, Neanderthal fossils extend from Gibraltar and Zafarraya in southern Spain to Belgium (Spy, Engis), across Germany (Neander Valley) and Italy (Monte Circeo), through the Czech Republic (Kulna), Hungary (Sübalyük) and Croatia (Vindija), and into Ukraine (Kiik-Koba) and western Asia. The largest series is found in France, with important specimens from La Chapelle-aux-Saints, La Quina, La Ferrassie, Le Moustier, and Saint-Césaire. Many of these specimens are poorly dated but appear to range between 100 and 40 Ka. The youngest-known Neanderthals include those from Saint-Césaire (36 ± 3 Ka), Arcy-sur-Cure (Grotte du Renne, 33.8 ± 0.7 Ka), Zafarraya (ca. 33–30 Ka), and Figueira Brava (Portugal, 31 ± 0.7 Ka). It is especially intriguing that the latest populations appear to have inhabited southern Iberia, perhaps seeking refuge from the advancing "moderns," even in warmer environments than usual. Northern sites of this period are poorly known, but one might predict finding additional late Neanderthals in northwestern Europe, another marginal region.

Neanderthals are associated most consistently with the Mousterian archaeological complex in Europe. In Southwest Asia, early anatomically modern humans (at Skhūl and Qafzeh) as well as Neanderthals are found with Mousterian assemblages; in Morocco, Mousterian tools are associated with the transitional archaic-modern Jebel Irhoud population. The essential characteristics of the Mousterian, described above, probably reflect increasing use of hafted stone tools in place of heavy core tools such as Acheulean bifaces. Variants of the Mousterian have been recognized on the basis of relative frequencies of Acheulean bifaces, blanks struck with the Levallois technique, and a wide range of morphologically distinct retouched tools. F. Bordes used this typology to identify six major Mousterian variants: Typical, Denticulate, Charentian (with Ferrassie and Quina subvariants), Mousterian of Acheulean Tradition (with MTA A and MTA B subvariants), Vasconian, and Asinipodian, the latter two being found mainly near the Mediterranean coast. Bordes argued that the differences between these industries reflected different Neanderthal cultures or ethnic groups. In contrast, L. Binford ascribed the same variation to functional variability (i.e., differing relative frequencies of tasks carried out at specific sites). Much Mousterian variability is now understood to reflect the influence of raw materials, mobility patterns, and tool function, use, and resharpening, as well as sequential changes in culture. There are broad typological and technological continuities across much of the European Mousterian. Nevertheless, some regional differences are apparent (e.g., the relatively higher frequencies of bifacial core tools in eastern Europe). The very end of the Middle Paleolithic witnesses the development of typologically distinct industries with restricted geographic distributions, such as Uluzzian (Italy), the Mousterian of Acheulean Tradition (central France), and the Altmuhlian (central-southeastern Europe). Some key Mousterian sites include Le Moustier, Combe Grenal, La Ferrassie, La Quina, L'Hortus, La Chapelle-aux-Saints, Pech de l'Azé, and Le Regourdou (all in France); Krapina (Croatia); Monte Circeo (Italy); and Gorham's Cave (England).

Occasional blade technologies appear especially after 100 Ka in the Lower-Middle Rhine region of Germany, northern France, and the Netherlands. Leaf-shaped points, which may have been hafted, are an even later phenomenon in the east, dating to 70 Ka or later. Changes in ranging pattern, food procurement, and lithic technology are also documented for central Italy after 55 Ka. Indeed, some authors have interpreted these and other technological developments (an increase in Upper Paleolithic tool forms) as indications of earlier contact between Neanderthals and anatomically modern humans; blades and points are a prominent feature of African Middle Paleolithic industries from the beginning, and of Southwest Asian industries, as well. (In the latter case, the points are rarely leaf shaped and almost never bifacially worked). Most authors, however, see these developments in Europe as purely local variants of Middle Paleolithic industries.

On the strength of the faunal evidence from archaeological sites, Middle Paleolithic Neanderthals appear to have practiced somewhat more predatory strategies or more effective scavenging than their predecessors. Numerous ashy con-

centrations from Mousterian sites attest to control over fire, although there are few signs of *warmth banking*, such as heating stones around hearths. Some Mousterian sites feature substantial (more than 1 m in diameter) pits that may have served as storage places, but this interpretation is controversial. Like their predecessors, some Mousterian sites (e.g., Molodova 1, Level 4) feature alignments of bones and stones that could represent simple shelters, but there are few clear signs of internal structure to Mousterian occupations. Most sites are probably palimpsests (multiple overlays) of numerous short-term occupations. Whether because of their biological or their cultural adaptations, Neanderthals may have been the first inhabitants of the cold steppe and periglacial regions of northeastern Europe.

As with the Early Paleolithic, there are few signs of long-distance transport of raw materials. Unlike Early Paleolithic sites, however, some Mousterian sites contain skeletons of adults and juveniles in anatomical articulation. The more complete skeletons have been interpreted as burials, although this is disputed by some scholars. Some perforated bones and teeth and lumps of mineral pigments (ocher and manganese), including those with signs of use (which are called *crayons*), as well as a putative bone flute from Divje Babe (Slovenia), may hint at more complex symbolic dimensions to Mousterian behavior, but most of this evidence involves singular finds from sites scattered widely in space and time.

Modern Humans and the Upper Paleolithic

The term *Upper Paleolithic* is used widely in Europe to refer to blade-and-burin industries that show the social, economic, and symbolic intensification typical of the Late Paleolithic as understood in this book. The latter term is used globally (like Middle Paleolithic), while the former is here restricted to Europe and southwestern Asia (analogous to Mousterian or MSA). In Europe, the appearance of anatomically modern humans coincides with a technological transition from Middle Paleolithic prepared-core technologies to Late Paleolithic prismatic-blade industries. Whether the Middle-Upper Paleolithic transition is meaningfully linked to the phyletic transformation or the extinction and replacement of Neanderthals is the subject of major debate.

The Middle-Upper Paleolithic transition occurred during a period of moderate climatic amelioration ca. 38–30 Ka, and it seems to have taken different forms and followed different time trajectories in different parts of Europe. The earliest Upper Paleolithic industry in France is the Châtelperronian, which is represented at such sites as Arcy-sur-Cure (Grotte du Renne), Saint-Césaire, Le Piage, Roc de Combe, and Le Moustier. The Châtelperronian features Levallois prepared-core, as well as prismatic-blade, techniques and numerous steeply backed blades. A number of worked-bone objects, including awls, and perforated and incised animal teeth have also been found in Châtelperronian contexts. Because of its backed-blade component, the Châtelperronian was once regarded as the earliest phase of a developmental sequence culminating in fully Upper Paleolithic Perigordian/Gravettian industries (and thus was often called Perigordian I). Now, most researchers regard the Châtelperronian as an outgrowth of late Western Mousterian (most likely the MTA B) with an infusion of Late Paleolithic cultural elements. It is difficult to tell whether the seemingly Upper Paleolithic components of the Chatelperronian reflect indigenous innovations or influences from contemporaneous Aurignacian cultures. Chatelperronian occupations may be stratified between Aurignacian occupations at Le Piage and Roc de Combe.

Following discoveries of Neanderthal remains in Chatelperronian levels at Grotte du Renne and Saint-Césaire, many researchers associate the Chatelperronian with relict Neanderthal populations. A similar interpretation seems plausible for the transitional Uluzzian industry from Italy and Greece. From the British Isles to the North European Plain, to Germany, Poland, and the Carpathians, a number of such transitional industries (the Lincombian, Altmuhlian, Szeletian, and Jermanowican) feature large, bifacially thinned points. The hominin fossil associations for these industries are not yet clear. While Mousterian and transitional industries may continue in very limited areas (e.g., southern Spain) until ca. 30–28 Ka, after this date there are no known Mousterian sites or Neanderthal remains.

The arrival of the Aurignacian, the first fully Upper Paleolithic industry in most areas, represents an abrupt discontinuity with past industries. In no case can the Aurignacian be derived from a local predecessor. The earliest Aurignacian sites, predating 40 Ka, are in the Balkans (Bacho Kiro and Temnata, both in Bulgaria). By ca. 40–38 Ka, Aurignacian sites are known from the central Danube Basin (e.g., Istállöskö) and northeastern Spain (Arbreda, Castillo). The late survival of Neanderthals and Mousterian industries in southern Iberia suggests that the Spanish Aurignacian sites represent a diffusion from the east rather than a separate movement of anatomically modern humans across the straits of Gibraltar—in any case, Aurignacian-like industries are absent in North Africa at this time.

Indeed, the Aurignacian has no known antecedents outside Europe, particularly in the region from which anatomically modern humans might most reasonably have migrated: North Africa and Southwest Asia. The Aurignacian is found in the Levant, but only after ca. 36 Ka, where it appears to represent an intrusive cultural element into a sequence of local Upper Paleolithic industries derived from the Mousterian (Ahmarian, transitional industry at Boker Tachtit). This Levantine Aurignacian has been compared to the Aurignacian of the Balkan region and may represent a migration from that area into western Asia. The Aurignacian as a whole may possibly be derived from Mousterian industries farther east, such as the Zagros Aurignacian or the Baradostian of Shanidar (Iraq) and Warwasi (Iran), but this is very debatable. It is more likely that the Aurignacian represents a European adaptation by a new population to the unique conditions and opportunities of that region, much as Clovis may have represented a new and dynamic response to the opportunities of North America. Such innovation may spread relatively rapidly, although it is now clear that the Aurignacian and the Upper Paleolithic in general took at least 6 Kyr to reach much of the European continent and more than

10 Kyr to entirely supplant Mousterian industries and associated Neanderthals.

Faunal assemblages from Aurignacian sites indicate a wide range of hunting strategies, with a greater emphasis on reindeer than seen in most Mousterian sites. Faunal assemblages associated with this and later Upper Paleolithic industries feature larger proportions of steppe and tundra species, such as mammoth, horse, ibex, and reindeer, reflecting the increasingly colder conditions. Much of the faunal evidence points to Upper Paleolithic groups intercepting large mammal herds at strategic points along migration routes, a strategy that implies considerably greater logistical planning and flexibility than is evident in the Mousterian. Aurignacian sites also include small, deep pit-hearths with heating stones, capable of high temperatures and long-term heat conservation. Mediterranean shells found far inland, ivory from outside the apparent range of mammoths, and exotic flint materials from many Aurignacian sites point to exchange networks that were more extensive than Middle Paleolithic ones. Aurignacian sites also contain some of the earliest Paleolithic images, in the form of musical instruments and carved bone and ivory figurines, as well as other carved, incised, notched, and perforated objects with multiple symbolic meanings. The earliest occurrences of parietal art from French sites such as Chauvet and Gargas may date to the later phases of the Aurignacian.

The identity of the early Aurignacian groups is one of the greatest mysteries of Upper Paleolithic archaeology. Early modern humans were first recovered at the classic site of Cro-Magnon in France, but their association with the early Aurignacian industry at the type site is uncertain, due to the nature of the 1869 excavations. Most purportedly early Aurignacian skeletal remains are either highly fragmentary (e.g., Vindija, Barma Grande) or in questionable stratigraphic associations (e.g., Combe Capelle, Engis 2, Grotte des Enfants [Grimaldi], Mladeč).

Aurignacian industries are followed by Perigordian or Gravettian ones, characterized by backed points, ca. 28–20 Ka. A variety of hafted projectile-point types suggests increased sophistication in hunting weaponry. Although Gravettian sites are linked by backed-tool technology and carved female figurines, such as the "venuses" of Willendorf (Austria), Lespugne and Laussel (France), and Dolni Věstonice (Czech Republic), the degree of regional variation across the vast area involved suggests the presence of ethnic signatures in the archaeological materials. The eastern European variant of the Gravettian, extending through Ukraine and Russia, is particularly rich in carved female and animal figurines and in elaborate burials (e.g., Sungir). At Dolni Věstonice figurines of clay and loess were apparently baked at temperatures of up to 800°C, possibly as part of a ritual sequence. Storage pits and piles of mammoth bones for food, fuel, and hut or windbreak construction reflect a greater degree of planning in daily life. Textile impressions on clay pellets from this site suggest the manufacture of twined baskets or other twined fabrics by Gravettians.

During the last glacial maximum (22–18 Ka), northern Europe—including England, Belgium, northern France, and Germany—was either abandoned or very sparsely populated. The same gap in occupation is evident in many central and eastern European sites, including those of Ukraine and Russia. In southern France and Spain during this time, on the other hand, Solutrean industries reflect greatly improved hunting specializations as well as the most refined stone-tool technology of the Paleolithic, with beautifully flaked foliate and shouldered points. Bone needles with eyes suggest refinements in dress and personal adornment, while elaborate bas-reliefs decorate the walls of some rockshelter living sites, such as at Roc de Combe and Cap Blanc (France).

In northern and western Europe and extending to Poland, Austria, and the Czech Republic, Magdalenian industries (18–11 Ka) with increasingly specialized economies, microlithic technology, and elaborate bone working complete the classic Upper Paleolithic sequence. This sequence is based on deeply stratified sites such as Abri Pataud, Laugerie Haute, Roc de Combe, La Madeleine, and La Ferrassie, all in southwestern France. New Magdalenian hunting implements include the barbed point, harpoon, atlatl, and an array of fishing implements and net weights; the evidence indicates extensive use of fish and birds and specialized reindeer hunting at suitable intercept locations. A number of freestanding structures known from open-air sites include simple huts and clusters of tent foundations (possibly windbreaks) such as at Plateau Parrain, Gönnersdorf, and Pincevent. Magdalenian sites also represent the high point of large-scale ritual and symbolic activity, documented not only in the elaboration of carved bone and antler objects in living sites, but also in deep painted-cave sites like Font-de-Gaume, Lascaux, and Altamira. Indeed, most of the painted, sculpted, carved, and engraved images that make up the rich record of Upper Paleolithic art date to this period. Microregional variations in tool types and art forms suggest ethnic differentiation on a new and more intensive scale. One interpretation is that the Magdalenian was a period of population growth and eventual resource stress, which resulted in increasing territoriality, intensification of symbolic behavior, and the greater use of small-scale resources. This conclusion is borne out by bioarchaeological studies that have shown greater indicators of stress (Harris lines, enamel hypoplasias) in Magdalenian skeletons than in those of the Solutrean or early Upper Paleolithic.

In southern and eastern Europe, a tendency to microlithic tool technologies is also evident but without the specific cultural markers of the Magdalenian. These industries are sometimes grouped as Evolved Gravettian or Epigravettian and contain endscrapers, burins, perforators, backed and truncated blades, bone awls, needles and points, and numerous microlithic tools at sites such as Grimaldi (Italy), Kostenki-Borshevo (Russia), and Molodova and Mezhirich (Ukraine). On the Russian Plain, elaborate dwellings of mammoth jaws and tusks alongside much simpler ones, as well as considerable differences in the quantities of exotic materials, some from hundreds of miles away, imply the existence of trade routes, social stratification, and interpersonal and intergroup complexity on an unprecedented scale for Paleolithic people, far beyond that seen in western Europe.

The Early Postglacial: Mesolithic and Neolithic

Deglaciation began ca. 18 Ka and accelerated rapidly after that point to ca. 8 Ka. During this period, sea levels rose rapidly and steppe-tundra zones retreated northward, replaced by successive waves of boreal and deciduous forest. The archaeological cultures of this period are called *Mesolithic,* and they differ from their predecessors primarily in featuring larger proportions of microliths that have been truncated and backed into geometric forms, such as crescents, triangles, trapezoids, and rectangles. The appearance of these microliths is generally thought to signal the greater use of the bow in hunting. Mesolithic subsistence was based to a greater extent on hunting of solitary and small herd-game, as well as on fishing and birding. On the newly deglaciated North European Plain, sites such as Hohen Viecheln suggest that the first human occupants of these regions (e.g., Ahrensburgian and Hamburgian groups) continued late-glacial hunting adaptations, focus on reindeer and elk. Later North European Mesolithic groups, such as the Maglemosian, increasingly focused their efforts on red deer, wild cattle, and marine mammals. Mesolithic cultures from the temperate forests of Europe, such as the Azilian, Tardenoisian, Sauveterrian, and Montadian, furnish evidence of scheduled exploitation of forest resources, including acorns, hazelnuts, wild cattle, boar, fallow deer, red deer, and ibex. The British waterlogged site of Star Carr has provided detailed information about Mesolithic economic activities, including evidence for domesticated dog. In general, the Mesolithic witnesses a decline in long-distance connections between different regions and an increasingly local and regional scale of social organization. Later Mesolithic sites are concentrated around more productive estuarine areas, where prolonged shellfish collection created enormous middens (piles of discarded shells). The cemetery of Vedbaek (Denmark) provides evidence for complex Mesolithic mortuary rituals. Both the quantity and the quality of representational art declines markedly at the Paleolithic-Mesolithic transition.

Neolithic farming economies featuring cereal cultivation and domesticated sheep, goat, cattle, and pigs first appear in southeastern Europe ca. 8 Ka and nearly simultaneously along the Spanish and French Mediterranean. In southeastern Europe between 8 and 6 Ka, sites such as Karanovo, Aichilleon, and Sesklo provide long sequences of Early Neolithic occupations whose architecture, ceramic designs, and mortuary practices clearly point to influences from earlier Neolithic cultures in Anatolia. The origins of the Southwest European Neolithic (called the *Cardial Neolithic* after distinctive *Cardium* shell impressions in its pottery) are less clear. The presence of Cardial Neolithic sites on the Moroccan coast could suggest dispersal of agriculture to Europe from North Africa. The period between 7.5 and 6.5 Ka witnessed the spread of agriculture into temperate Europe. The first phase seems to have involved a rapid dispersal, probably an actual physical migration of peoples along the Danube, where the Linearbandkeramik culture is associated with rich loessal soils. The spread of the Neolithic along the Atlantic coast is less well documented, but it appears to have been accompanied by *Megalithic* traditions involving large earthen barrows and stone chambered tombs. By 5.5 Ka, Neolithic farmsteads had been established in the northernmost reaches of the British Isles and Scandinavia. Trade patterns in the Neolithic were extremely complex, involving the dispersal of flint, stone axes, amber, shells, gold, copper, tin, and other materials through a variety of overlapping networks. These trade networks appear to have been a significant factor in the rise of Bronze Age chiefdoms and states.

See also Abbevillian; Abri Pataud; Acheulean; Adapidae; Adapiformes; Africa; Altamira; Ambrona; Anaptomorphinae; Arago; Archaeological Sites; Archaic Homo sapiens; Asia, Eastern and Southern; Asia, Western; Atapuerca; Aurignacian; Azilian; Bacho Kiro; Biache-St. Vaast; Bilzingsleben; Blade; Bordes, François; Burin; Catarrhini; Cenozoic; Ceprano; Cercopithecidae; Cercopithecinae; Chatelperronian; Chauvet Cave; Chilhac; China; Chopper-Chopping Tools; Clactonian; Colobinae; Cro-Magnon; Cyclostratigraphy; Dmanisi; Dolni Věstonice; Domestication; Dryopithecinae; Early Paleolithic; Economy, Prehistoric; Engis; Eocene; Fire; France; Gargas; Glaciation; Gravettian; Grimaldi; Griphopithecus; Hamburgian; Handaxe; Holocene; Hominidae; Hominoidea; Homo sapiens; Isernia; Istallöskö; Kostenki; Krapina; L'Escale; L'Hortus; La Chapelle-aux-Saints; La Cotte de St. Brelade; La Ferrassie; La Quina; Lagar Velho; Lantian; Lascaux; Laugerie Sites; Le Moustier; Lehringen; Levallois; Longgupo; Magdalenian; Maglemosian; Mauer; Mesolithic; Mezhirich; Microchoerinae; Middle Paleolithic; Miocene; Mladeč; Modjokerto; Molodova; Monte Peglia; Montmaurin; Mousterian; Neanderthals; Neolithic; Nihewan; Notharctidae; Omomyidae; Oreopithecus; Paleobiogeography; Paleocene; Paleolithic; Paleolithic Calendar; Paleolithic Image; Paleolithic Lifeways; Paromomyidae; Périgord; Perigordian; Petralona; Pincevent; Plate Tectonics; Pleistocene; Plesiadapidae; Plesiadapiformes; Pliocene; Pliopithecidae; Ponginae; Pontnewydd; Prepared-Core; Přezletice; Raw Materials; St. Acheul; Saint-Césaire; St. Eble; Sangiran Dome; Sauveterrian; Saxonellidae; Scraper; Sea-Level Change; Site Types; Soleihac; Solutrean; Star Carr; Steinheim; Stone-Tool Making; Stranská Skála; Swanscombe; Szeletian; Tardenoisian; Tarsiiformes; Tayacian; Terra Amata; Time Scale; Vallonnet; Venosa Sites; Vértesszöllös; Vindija; Yuanmou. [E.D., A.S.B., J.J.S.]

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