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NUMBER 1

THE OLDOWAN:
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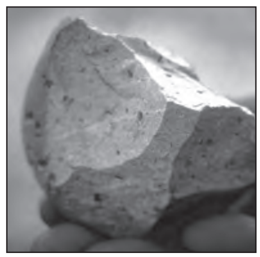

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COVER PHOTOS

Front, clockwise from upper left:

1) *Excavation at Ain Hanech, Algeria (courtesy of Mohamed Sahnouni).*

2) *Kanzi, a bonobo ('pygmy chimpanzee') flakes a chopper-core by hard-hammer percussion (courtesy Great Ape Trust).*

3) *Experimental Oldowan flaking (Kathy Schick and Nicholas Toth).*

4) *Scanning electron micrograph of prehistoric cut-marks from a stone tool on a mammal limb shaft fragment (Kathy Schick and Nicholas Toth).*

5) *Kinesiological data from Oldowan flaking (courtesy of Jesus Dapena).*

6) *Positron emission tomography of brain activity during Oldowan flaking (courtesy of Dietrich Stout).*

7) *Experimental processing of elephant carcass with Oldowan flakes (the animal died of natural causes). (Kathy Schick and Nicholas Toth).*

8) *Reconstructed cranium of Australopithecus garhi. (A. garhi, BOU-VP-12/130, Bouri, cranial parts, cranium reconstruction; original housed in National Museum of Ethiopia, Addis Ababa. ©1999 David L. Brill).*

9) *A 2.6 million-year-old trachyte bifacial chopper from site EG 10, Gona, Ethiopia (courtesy of Sileshi Semaw).*

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Photographs of the Stone Age Institute. Aerial photograph courtesy of Bill Oliver.

Published by the Stone Age Institute.
ISBN-10: 0-9792-2760-7
ISBN-13: 978-0-9792-2760-8

CHAPTER 5

AFTER THE AFRICAN OLDOWAN: THE EARLIEST TECHNOLOGIES OF EUROPE

BY FERNANDO DÍEZ-MARTÍN

ABSTRACT

The starting point of this paper is the issue of the first occupation of Europe, which has been subject of an intense debate for the past few decades and has been polarized by two antagonistic perspectives: the 'long chronology' and the 'short chronology'. To present the state of our knowledge on this topic, a brief summary of some recent key publications is considered. Then, the geological and chronological framework of the earliest European sites with Mode 1 features is provided along with a general overview of the technological characteristics observed in them. Finally, some of the possible explanatory hypotheses of these pre-500 Ka. European Mode 1 industries are presented and briefly discussed.

KEYWORDS:

Europe, Lower and Middle Pleistocene, Mode 1 technologies, Lower Palaeolithic, variability, occupation.

INTRODUCTION: THE EARLIEST OCCUPATION OF EUROPE, A MATTER OF CONTROVERSY

At the beginning of the 1990's, the idea of an early human colonization of Europe still was a strong paradigm among some scholars. This situation was possible in part due to a tradition that provided a long list of Lower Pleistocene sites and isolated finds scattered around the continent. The meeting on *The First Europeans*, held in 1989 (Bonifay & Vandermeersch, eds., 1991), is a significant example of how the archaeological record then supported this interpretation. The French Massif Central and Southeastern regions seemed to provide a wealth of early evidence, some of which could be taken back to the Upper Pliocene (among them, Saint-Elbe, Soleilhac and Chilhac are the best known cases). All over Europe there were sites that, considering their absolute dating, faunal remains, geostratigraphy or, simply, their technological features, seemed to date to the Lower and Early Middle Pleistocene, such as the cases of Vallonet (southeastern France), El Aculadero and Orce (southern Spain), Isernia and Monte Poggiolo (Italy), Kärlich (Germany) or Stránská Skála (Czech Republic). Finally, Lower Pleistocene fluvial terraces completed this picture with a high density of sites, including those within river deposits in Spain, Italy and France.

All these data seemed to lend consistent support to the human occupation of Europe almost immediately after the African origin of the genus *Homo*. Although such expansion eventually spread throughout Europe, the main accumulation of discoveries was located in the Mediterranean regions. Every single archaeological case exhibited a technology similar to that seen at the early African sites: Oldowan-like choppers, polyhedrons, discoids, débitage and casually retouched flakes. From this perspective, this 'simple' or 'Mode 1' technology (industries characterized by Oldowan-like cores such as 'choppers,' 'discoids,' 'scrapers,' etc., and an assortment of flakes and flake fragments, as well as a lack of more formal tools such as handaxes, cleavers, or picks) had been present in Europe for a long period of time. Moreover, these had been replaced by the Acheulean or 'Mode 2' industries containing such formal tools only at the beginning of the Middle Pleistocene (Bonifay & Vandermeersch, 1991).

This scenario, the **'long chronology' hypothesis** (also called the 'mature Europe' or 'old Europe' hypothesis), was never unanimously accepted (Dennell, 1983) and came into serious dispute in 1993. That year witnessed a scientific meeting at Tautavel (France) that brought together an important and heterogeneous group of European prehistorians who critically reviewed the issue of the first occupation of Europe (Roebroeks & van Kolfschoten, eds., 1995). By reviewing the archaeological assemblages related to its earliest occupation, almost all of these scholars concluded that the long chronology scenario was untenable. Roebroeks and van Kolfschoten (1994) used this new perspective to introduce their **'short chronology' hypothesis**, in which they stated that the first European occupation took place at about 500 Ka. ago and that before this date Europe had been almost empty. The new paradigm was based on the assumption that there was no irrefutable evidence of such an ancient human presence before 0.5 Ma. No human fossils had been found and the archaeological sites referred as "very old" were considerably problematic due to a number of reasons: in some cases they came from disturbed high-energy contexts or from sediments not securely dated; in others, lithic assemblages were apparently natural and not humanly manufactured; and finally, many finds from fluvial terraces and other areas were isolated pieces and therefore non-diagnostic.

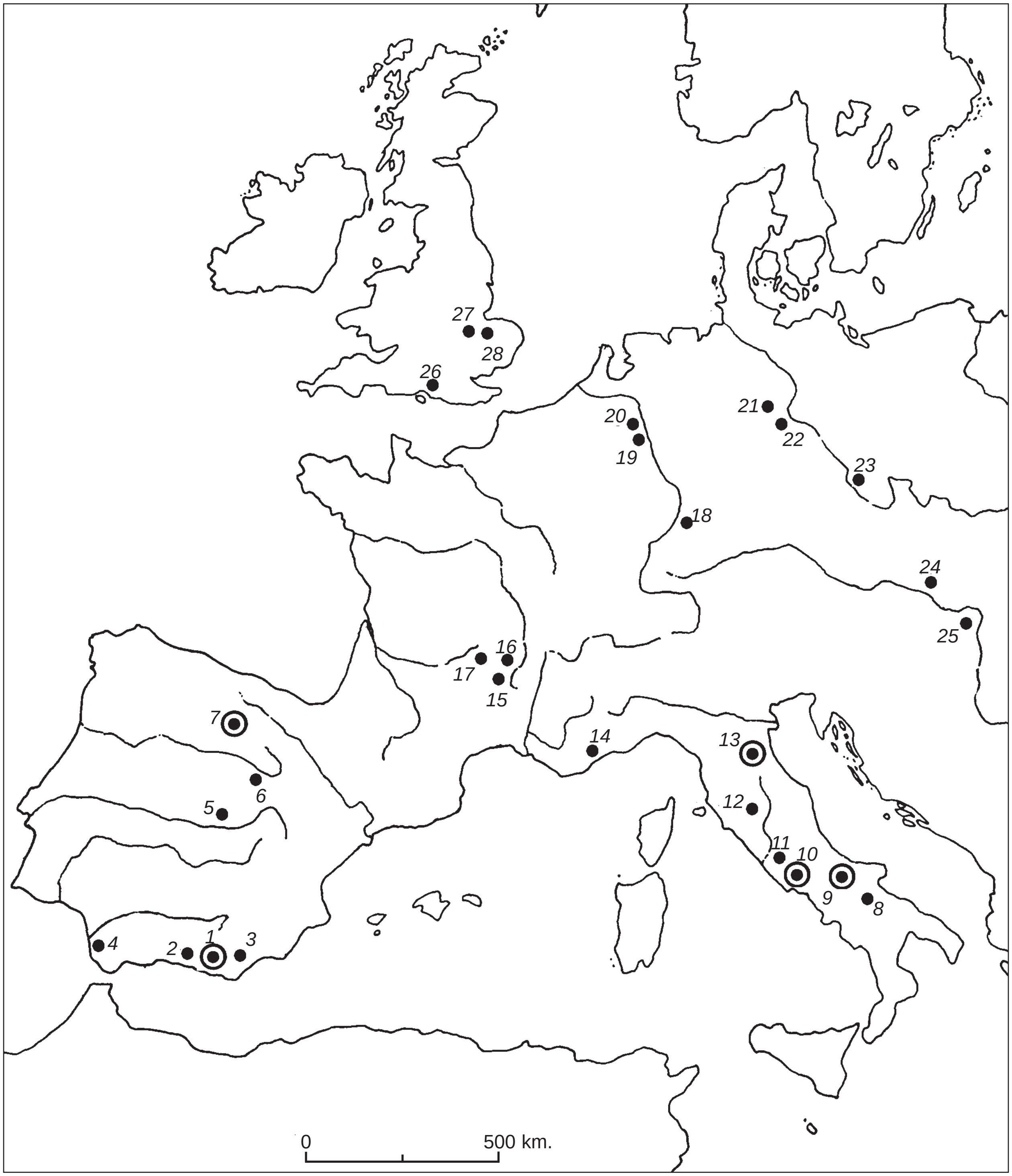
These arguments had a "ripple effect" that seemed rapidly to weaken the Old Europe view. Certainly, a very consistent point in favor of the new scenario was the absence of human remains before the Middle Pleistocene period. The **Orce** (Spain) skull fragment, found in sediments dated to about 1.07 Ma., had generated an intense controversy between those scientists who defended the human status of the fossil (Gibert *et al.*, 1994) and those who preferred to see it as a juvenile equid (Agustí & Moyà-Solà, 1987). These days, most researchers are inclined to reject this evidence as human (Moyà-Solà & Köhler, 1997; Gibert *et al.* 1998a). At the same time, the phalanx recovered in the Spanish Lower Pleistocene karstic site of **Cueva Victoria** (Palmqvist *et al.*, 1996a) is also debatable.

Table 1

site	country	chronology proposed	dating method	lithic assemblage (no.)	problematic	references
Prezletice	Czech Republic	890-600 Ka.	BS/PM	Mode 1 (870)	doubtful industry	Valoch, 1995
Stránská Skála	Czech Republic	>780 Ka.	BS/PM	Mode 1	doubtful industry	Valoch, 1995
Chilhac III	France	1.9-1.8 Ma.	BS	Mode 1 (48)	secondary site	Chavaillon, 1991
Soleilhac	France	900 Ka.	BS/ME/PM	? (400)	unclear sequence, biostratigraphy	Raynal *et al.*, 1995
Vallonet	France	900 Ka.	BS/PM/ESR	Mode 1 (59)	doubtful industry secondary site?	Lumley *et al.*, 1988
Kärlich A	Germany	>780 Ka.	BS/PM	? (3)	doubtful and scarce industry	Bosinski, 1995
Colle Marino	Italy	>700 Ka.	ME	—	reliability of regional correlations	Mussi, 1995
Monte Peglia	Italy	>780 Ka.	BS	? (5)	doubtful industry	Mussi, 1995
El Aculadero	Spain	780-500 Ka.	ME	Mode 1 (2769)	stratigraphic sequence revision	Raposo & Santonja, 1995
Cúllar-Baza I	Spain	780-500 Ka.	BS/ME	? (6)	scarce assemblage	Santonja & Villa, 1990
Duero/Guadalquivir (upper terraces)	Spain	780-500 Ka.	ME	-	isolated pieces	Santonja & Villa, 1990
Korolevo VII/VIII	Ukraine	>780 Ka.	PM/TL	Mode 1 (1900)	ambiguous dating	Gladiline & Sitlivy, 1990

Table 1: Some problematic early European sites in stratigraphic context (dating method: BS = biostratigraphy; ESR = electro spin resonance; ME = morphostratigraphy; PM = paleomagnetism; TL = thermoluminiscence).

Figure 1



1. *Geographic location of the European sites mentioned in the text:*
SPAIN:1. Barranco León and Fuente Nueva 3; 2. Orce; 3. Cúllar-Baza I; 4. El Aculadero; 5. Áridos; 6. Ambrona; 7. Atapuerca TD6. ITALY: 8. Notarchirico; 9. Isernia la Pineta; 10. Ceprano; 11. Colle Marino; 12. Monte Peglia; 13. Monte Poggiolo. FRANCE: 14. Vallonet; 15. Soleilhac; 16. Chilhac; 17. Saint-Elbe. GERMANY: 18. Mauer; 19. Miesenheim; 20. Kärlich; 21. Schöningen; 22. Bilzingsleben. CZECH REPUBLIC: 23. Prezletice; 24. Stránská Skála. HUNGARY: 25. Vértesszölös. GREAT BRITAIN: 26. Boxgrove; 27. High Lodge; 28. Barnham.

Some of the major site occurrences that, after further scrutiny, totally or partially confirm Roebroeks and van Kolfschoten's 'short chronology' hypothesis will be discussed here (a more extensive list of sites and their characteristics is presented in table 1; also see figure 1 for the location of the archaeological sites mentioned). The French Massif Central has currently lost its status as a source for early Palaeolithic sites. Many of the reported localities were indeed very small collections or even isolated pieces that, on occasion, might be explained as geofacts, naturally produced by volcanism in the region (Raynal *et al.*, 1995). Some of the better-known sites have important problems and, so far, do not provide consistent evidence. For example, **Chilhac III**, a site that has provided a small collection of doubtless artifacts (Chavaillon, 1991: 82), has had significant stratigraphic disturbance. The association of lithics and Villafranchian fauna (Late Pliocene and Early Pleistocene) supported a date of 1.8 Ma. for this site based on biochronology. However, the deposits in which lithic implements and fauna have been found seem to have been affected by solifluxion and transport that could well have mixed materials of different ages (Villa, 1991: 211; Raynal *et al.*, 1995: 138).

Soleilhac, for its part, is poorly known. The lithic collection has not been published in detail and, even though an age of 0.9 Ma. has been proposed (Bonifay, 1991: 70), this date is inconclusive. The stone tools are associated with a post-Villafranchian fauna, a not very precise biochronological marker that could easily be of Middle Pleistocene age (Roebroeks & van Kolfschoten, 1994: 498). Paleomagnetic and morphostratigraphic data, which supports the older date, can only be taken as tentative because the geological history of the site is poorly known (Raynal *et al.*, 1995: 139-140).

Vallonet Cave, in southwest France, is a site frequently brought to this debate. The fertile deposits are located in a small 5 m long area and have been dated consistently at 0.9 Ma. based on biostratigraphy, palaeomagnetism and ESR dates (de Lumley *et al.*, 1988; Yokoyama *et al.*, 1988). However, the question here does not pertain to the chronology but rather to the nature of the lithic assemblage. The 59 supposedly artifactual objects (76% made from limestone), come from deposits that contain sands and limestone cobbles. Natural sedimentary processes such as wave action could have produced natural fractures in the pebbles in this matrix. This suggests that the lithic assemblage is in fact a collection of non-artifactual objects (Roebroeks & van Kolfschoten, 1994). Other criticism of this site has focused on the fact that the supposed archaeological accumulation might be to some extent a secondary context and mixed assemblage (Villa, 1996: 71).

El Aculadero, in southern Spain, had been considered by many to be the most plausible candidate for an ancient human settlement in Iberia (Querol & Santonja, 1983), having been assigned to stage III of the now outdated *galet aménagé* culture of North Africa (Biberson, 1961). Although this site did not provide absolute dating or faunal remains, its chronological framework was estimated by considering the typological characteristics observed in the large lithic collection (2769 artifacts including choppers and flakes), and by the data provided by the morphostratigraphic sequence. Thus, a pre-Acheulean and pre-Middle Pleistocene framework was proposed (Santonja & Villa, 1990: 53). More recently, the geomorphologial sequence has been revised and, as result, the site is now considered to be significantly younger, dating to the end of the Pleistocene (Raposo & Santonja, 1995: 18).

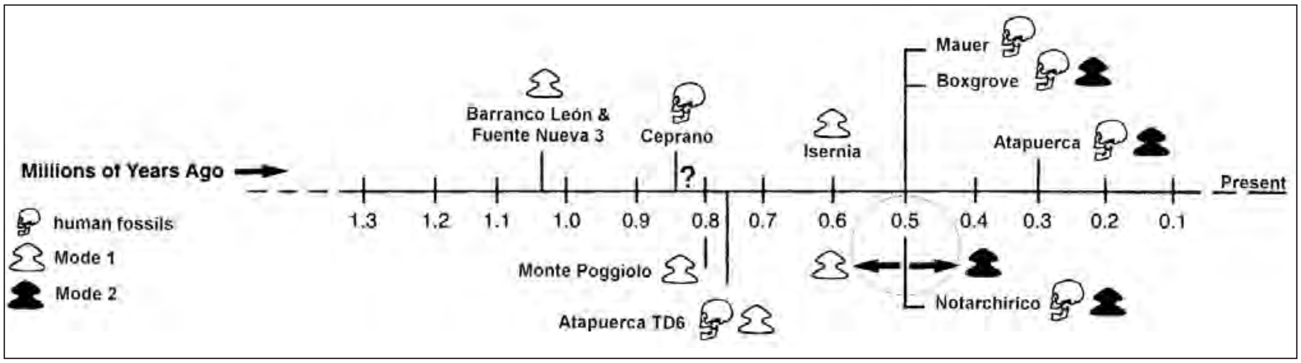
It seemed that, taking into account all this evidence (or better, the lack of it), the short chronology hypothesis was a very strong and accurate scenario to explain the first human occupation of Europe. According to this perspective, at about 0.5 Ma. the species *Homo heidelbergensis* extensively occupied the continent, producing a technology related to the fully developed Acheulean complex. The main archaeological evidence confirming this would be the British site of **Boxgrove** (Roberts *et al.*, 1995: 171-172) — a primary context site in which handaxes, associated with a *H. heidelbergensis* tibia, were produced — and the **Mauer** (Germany) mandible, both correlated with oxygen isotope stage 13, between 524 and 478 Ka[1]. In addition, after this date, Acheulean sites are very common all over Europe (see various contributions in Roebroeks & van Kolfschoten, eds., 1995).

Unfortunately, the pristine consistency of this proposal did not last long. In 1995 the research team working at the Spanish site complex of **Atapuerca** published their new discoveries from a 6-m^2 test excavation at **Gran Dolina** site, level **TD6** (Carbonell *et al.*, 1995a; Parés & Pérez-González, 1995). According to the new information available, stone tools, fauna and human fossils, ascribed to the new species *Homo antecessor* (Bermúdez de Castro *et al.*, 1997), were found at Aurora stratum, a layer bracketed dating to the Lower Pleistocene period, before the Matuyama/Brunhes transition at 780 Ka. This new information had considerable impact in the European paleoanthropological community. Apparently, this was the first time that a site could provide all the elements to refute the short chronology and to please the most skeptic prehistorians. Immediately, the TD6 occurrences supported and revitalized an idea that had been circulating before (Villa, 1983: 12-14): the first occupation of Europe took place at about 1 Ma. ago. The Atapuerca team defended this perspective in their 'mature Europe' hypothesis (Carbonell *et al.*, 1995b) (figure 2).

The 'mature Europe' or 'long chronology hypothesis' has been supported by other evidence that seems to

[1] The Italian site of **Notarchirico** could well fit within this chronological framework. Although radiometric analyses have provided some contradict dates, the microfaunal assemblage suggests a post-500 Ka. chronology for the entire series (Mussi, 1995:32). The lowermost stratigraphic levels include handaxes and they are interstratified with other levels in which only cores and flakes occur (Piperno *et al.*, 1999).

Figure 2



2. Chronological distribution of Mode 1 and Mode 2 sites in the European record.

be more consistent than that previously dismissed by Roebroeks and van Koflschoten. On the one hand, the human cranium discovered at the Italian locality of **Ceprano** (Ascenci *et al.*, 2000) has an estimated age of 900-800 Ka., based on regional geological correlations. The sediments bearing the Ceprano calvaria are considered to be slightly younger than layers containing volcaniclasts in the Priverno basin and dated by Ar/Ar analysis to around 1.0 Ma. The morphological traits observed in the fossil are in agreement with this age. Recently, it has been remarked that the Ceprano specimen represents a 'bridge' between *H. ergaster/erectus* and *H. heidelbergensis* (Manzi *et al.*, 2001) and, therefore, the hypothesis that the Italian fossil might be the first adult cranial specimen of *H. antecessor* is possible (it must be remembered that a similar phylogenetic bridge pattern was suggested for *H. antecessor* morphology). On the other hand, further and more intensive investigation at sites like **Fuente Nueva 3** or **Monte Poggiolo** is of importance here and will be discussed below.

Although, at present, the debate on this issue is quite polarized between those who still support the 'short chronology' scenario (Roebroeks & van Kolfschoten, 1998; Gamble, 1999: 115-123) and those who back the 'mature Europe' hypothesis, it seems evident that Roebroek's and van Kolfschoten's perspective (at least in its original formulation) does not constitute the most useful model. Unexpectedly, the debate on the first human occupation of Europe has become more lively and the evidence more complex than ever. According to the archaeological record at hand, discussion of the *first* occupation of Europe primarily refers to Southern/Mediterranean Europe. It is important to note that this region may be more exposed to the influences of the first human settlement in North Africa (Sahnouni & Heinzelin, 1998; Raynal *et al.*, 2001) or the Caucasus (Gabunia *et al.*, 2000) and is certainly ecologically more hospitable for habitation by early human groups than are northern latitudes (Turner, 1992; 1999a).

The Earliest Archaeological Sites and Their Contexts

This chapter will focus on the archaeological sites that provide the most consistent evidence supporting the mature Europe hypothesis. Although not everyone agrees with this perspective (see especially Roebroeks & van Kolfschoten, 1998), the available information firmly brackets these sites within a period of time that precedes 500 Ka. The archaeological sites to be considered within this time span (1.0 Ma. to 0.5 Ma.) are, from older to younger: **Barranco León, Fuente Nueva 3, Atapuerca TD6, Monte Poggiolo**, and **Isernia la Pineta.**

Fuente Nueva 3 and Barranco León, Spain

Both of these Mode 1 sites are located in the north-eastern area of the Guadix-Baza Basin (Spain), well known for its rich and complete Pleistocene macro-mammal sequence (Martínez-Navarro *et al.*, 1997). The sites form part of the lacustrine sediments of the Baza Formation, which contain limestones, carbonate silts and dark mudstones. The stratigraphic section at Fuente Nueva 3 has three fossiliferous strata deposited in a low-energy situation: level 1 is a 5 cm thick layer rich in faunal remains; level 2 is 2-5 cm thick and is an archaeological stratum with lithic objects; level 3 contains both fauna and artifacts. The absence of tooth marks and the low percentage of carnivores indicate that the accumulation of the fauna was not due to predator activity. At Barranco León there is a 35 cm thick level of fine-grained sand, containing archaeological remains. The correlation between both sites has been impossible so far due to lateral facies changes, but it has been suggested that Barranco León might be stratigraphically below Fuente Nueva 3 (Oms *et al.*, 2000).

The chronological framework of these two sites has been estimated by a number of different methods. First, the macromammal fauna at Fuente Nueva 3 shows a Lower Pleistocene context (Martínez-Navarro *et al.*, 1997: 615-617) related to the much better known assemblages of Fuente Nueva 2 and Venta Micena (Palmqvist *et al.*, 1996b). In terms of rodents, the presence of *Allophaiomys bourgondiae* in the micromammal assemblage, more primitive than the *Microtus nivaloides* found at Vallonet and Atapuerca TD6, confirms that the biostratigraphic position of Fuente Nueva 3 (and subsequently Barranco León) should be located in an earlier Lower Pleistocene period. The first palaeomagnetic studies at FN3 showed a succession of reversed strata in the sequence, interpreted as part of the Matuyama chron (Martínez-Navarro *et al.*, 1997: 613). However, as the first analysis consisted of only 24 samples, new palaeomagnetic studies have been carried out recently, in which a total of 110 samples were analyzed at both sites (Oms *et al.*, 2000). This new study confirmed the reversed magnetization throughout the two sections and a Matuyama placement for both sites. These results, along with the biostratigraphic correlation, suggest an age that could be older than the Jaramillo normal subchron (0.99-1.07 Ma).

Gran Dolina TD4 and TD6, Spain

Gran Dolina is one of the sites located in the Sierra de Atapuerca archaeological complex (Spain). It is an 18 m thick sediment-filled gallery whose stratigraphic section has been exposed by a railway trench that cuts through the southwest area of the Sierra, made of Cretaceous limestone along with its associated cave breccias (Carbonell *et al.*, 1999a: 316). The cave infill is divided into 11 levels from, ascending TD1 to TD11, and contains both interior (TD1 and TD2) and exterior sediments (the rest of the sequence) (Parés & Pérez-González, 1999: 330-332). The levels with archaeological remains are TD4, TD6, TD10 and TD11. Only the first two levels fall in the scope of this paper. TD3-4 is a 2m thick unit consisting of sandy lutite that contains limestone clasts and has provided a small collection of five, doubtless human-made, lithic artifacts (Carbonell & Rodríguez, 1994). TD6 is a clastic unit that includes the Aurora stratum, a 20 cm thick lutite (fine-grained sedimentary) layer with limestone clasts that contains the important association of *Homo antecessor* fossils (Bermúdez de Castro *et al.*, 1997) and Mode 1 stone tools.

The chronology of the sequence has been assessed by three different methods. Paleomagnetic data show that at level TD7 there is a well-defined normal to reverse polarity switch that has been interpreted as the boundary between Matuyama and Brunhes chrons, that is to say, the transition between Lower to Middle Pleistocene at 780 Ma (Parés & Pérez-González, 1995; 1999). According to this information, the archaeological strata at TD4 and the overlying TD6, then, are older than this date. Micromammal biostratigraphy supports this chronological framework as well (Cuenca-Bescós *et al.*, 1999). The TD3-TD8 sedimentary section includes the rodent *Mimomys savini*, an important stratigraphic marker replaced by *Arvicola cantiana* during the Middle Pleistocene (Cromerian complex). No traces of the latter have been found in the Gran Dolina sequence, but the concurrence of a primitive *Mimomys* and an evolutionary stage of *Microtus* at TD5 and TD6 is related to the Late Biharian biochron at the end of the Lower Pleistocene (780-857 Ka.). Finally, a combination of U-series and ESR analyses has been carried out on fossil teeth at different stratigraphic units. The results for TD6 provided a mean age of 731± 63 Ka., which is in agreement with the paleomagnetic and biostratigraphic data (Falguères *et al.*, 1999). Taking all this information into account, TD6 level should be located at the end of the Early Pleistocene (i.e. >780 Ka.).

Monte Poggiolo, Italy

This Mode 1 site is found in northeast Italy, on the southeastern margin of the Po river valley. The archaeological locality lies on the Monte Poggiolo hill, 180 m. above sea level, in 5 m thick sandy coastal gravels. The sedimentary sequence of the area belongs to the Early Pleistocene: marine blue clays are overlain, to the southeast, by the Monte Poggiolo fluviatile sediments and, to the northwest, by coastal yellow sands. Pedogenic processes, tectonic activity and faulting have affected the sequence from the Middle Pleistocene onwards (Antoniazzi *et al.*, 1996).

The lowermost sediments, the infracoastal blue clays, have been correlated to a Matuyama, pre-Jaramillo age. ESR analysis carried out in the Monte Poggiolo area (where the transition from the blue clays to the fluviatile sediments is gradual) has furnished an age of 1.5 Ma. (Yokoyama *et al.*, 1992). A quarry opened in the yellow sands, 20 km. away from the archaeological site, has provided a macromammal collection that has been dated to the early Galerian biochron, 1.0-0.9 Ma. (Azzaroli *et al.*, 1988). This interpretation is in agreement with the paleomagnetic and ESR analyses, which locate these sediments in the Brunhes-Jaramillo interval, at about 1 Ma. (Mussi, 1995). Although the fluviatile deposits bearing the archaeological accumulation have no faunal remains, they have been correlated stratigraphically with the yellow sands and interpreted as a lateral facies of gravel-beach deltaic deposits that, due to a marine transgression, cut into the yellow sandy coastal sediments. Paleomagnetism and ESR analysis on quartz grains carried out on the detrital sediments of the archaeological site confirm this hypothesis, as they have provided an upper Matuyama age, around 800 Ka. (Peretto *et al.*, 1998). The geological and chronological information provided seems consistent with the idea that the whole sequence belongs to the Lower Pleistocene and that the fluviatile sediments, in which the important archaeological accumulation has been found, fall late in the Matuyama Chron.

The lithic assemblage is in fresh condition and shows no traces of significant fluvial or marine post depositional transport. This is supported by the 76 refittings recorded at the site. Some of them amazingly reconstruct the complete original core and each refitted group is found in the same stratigraphic level and in a narrowly defined area (Peretto *et al.*, 1998).

Isernia La Pineta, Italy

Isernia is a Mode 1 site located in central Italy. The site lies in lacustrine and fluviatile sediments that belong to the Pleistocene deposits that fill a Tertiary tectonic basin (Cremeschi & Peretto, 1988). The archaeological and faunal associations are present in four horizons separated in two different sectors (50 m. from each other). The stratigraphic series is as follows: in Sector I, level 3c is the oldest in the sequence and lies on a paleosurface, on top of travertine deposits which belong to the last episode of a lacustrine event; level 3a lies over fluviatile silty deposits that covered the travertine layers and contains an extremely dense faunal accumulation (mainly elephant, rhino and bison remains) associated with stone tools. After a phase of tectonic uplift and volcanic events, the fluvial deposits become dominant, and it is in this new regime that the other two horizons are found: level 3S10 and, in Sector II, level 3a which contains in a very thin layer, a very important accumulation of stone artifacts and almost no bones. The upper part of the series contains tuff sediments that indicate new volcanic activity. The dense concentrations of lithics and faunal remains, interpreted as living floors, have a good level of integrity and seem to indicate low energy deposition pattern (Villa, 1996).

The chronology of the site has been a matter of discussion for several years. K-Ar analysis on sanidine crystals from level 3a furnished an age of 736±40 Ka that seemed in accordance with a 550±50 Ka. date obtained in a later stratum at the top of the sequence. Paleomagnetic analysis showed, in addition, a reverse polarity that was interpreted as the Matuyama chron. (Coltorti *et al.*, 1982). However, the controversy rests on the fact that the biostratigraphic data do *not* support the absolute and paleomagnetic dating and, indeed, provide some contradictory measurements (Cremaschi & Peretto, 1988). The presence in the site of the rodent *Arvicola cantiana*, which marks the replacement of *Mimomys savini* at about 500 Ka., suggests that the site is younger (Roebroeks & van Kolfschoten, 1994). Recently, analysis of the macrofaunal assemblage, has led some paleontologists to suggest an age of about 0.6 Ka (Petronio & Sardella, 1999), which seems plausible and in agreement with recent Ar/Ar dates (Coltorti *et al.*, 2000).

The First European Technologies: A General Overview

In this section, the general technological trends observed in the lithic assemblages reviewed in this chapter are presented. For this purpose, the most recent information available for each archaeological collection will be used (Gibert *et al.*, 1998b; Oms *et al.*, 2000; Carbonell *et al.*, 1999a; Peretto *et al.*, 1998; Peretto, ed., 1994). However, to provide a detailed comparison between sites is a difficult task. It is important to note that it is problematic to compare the quantitative data offered by the different researchers. Some publications are comprehensive and show clear counts for all categories considered (i.e., artifact raw materials, dimensions, representative types and their proportions, etc.). Unfortunately, other publications are less complete. To provide a synthetic summary of the oldest European technologies, the emphasis here will be on general comparisons of quantitative information among the different sites, though in some instances more specific, qualitative information must be referred to.

Table 2 shows the number of lithic implements from each site and the general composition of assemblages by artifact classes or categories. At a glance, we can see that 50% of all artifacts are flakes, an important element in all the collections. On the other hand, the core category is quantitatively small in all the assemblages. To cite the extreme cases as examples, there is a core/flake ratio of 1:7 at Monte Poggiolo and of 1:18 at Barranco León. There is a mean ratio of 1:11 when all the assemblages are considered. Only the Spanish sites have been reported to contain hammerstones and manuports. In the case of Fuente Nueva and Barranco León a number of Jurassic dolomite cobbles have been considered manuports (Gibert *et al.*, 1998b: 21). At Atapuerca TD6, 19 quartzite, sandstone and limestone cobbles

Table 2

site	total lithics	cobbles/ hammerstones (%)	cores	flakes	retouched/ trimmed flakes	indet./ others
Barranco León	112	5 (4.46)	4 (3.57)	71 (63.39)	13 (11.60)	19 (16.96)
Fuente Nueva 3	120	20 (16. 66)	6 (5)	70 (58.33)	10 (8.33)	14 (11.66)
Atapuerca TD6	268	19 (7.08)	19 (7.08)	145 (54.10)	27 (10.7)	58 (21.64)
Monte Poggiolo	1319	—	153 (11.59)	1154 (87.49)	12 (0.90)	—
Isernia la Pineta	2567	—	160 (6.23)	1113 (43.35)	1294 (50.40)	—

Table 2: General composition of the assemblages under study.

have been recorded. These pieces have rounded or cubic shapes. The first shape type has been interpreted as hammerstones and the second as blanks chosen to be flaked (Carbonell *et al.*, 1999a: 672).

Raw Material Selection

The raw materials at all the sites are considered to be local in origin. Although this statement can apply as a general rule, it is interesting to evaluate each particular case in some depth, considering both the location of the procurement areas and the variety of rocks used at each spot (figure 3).

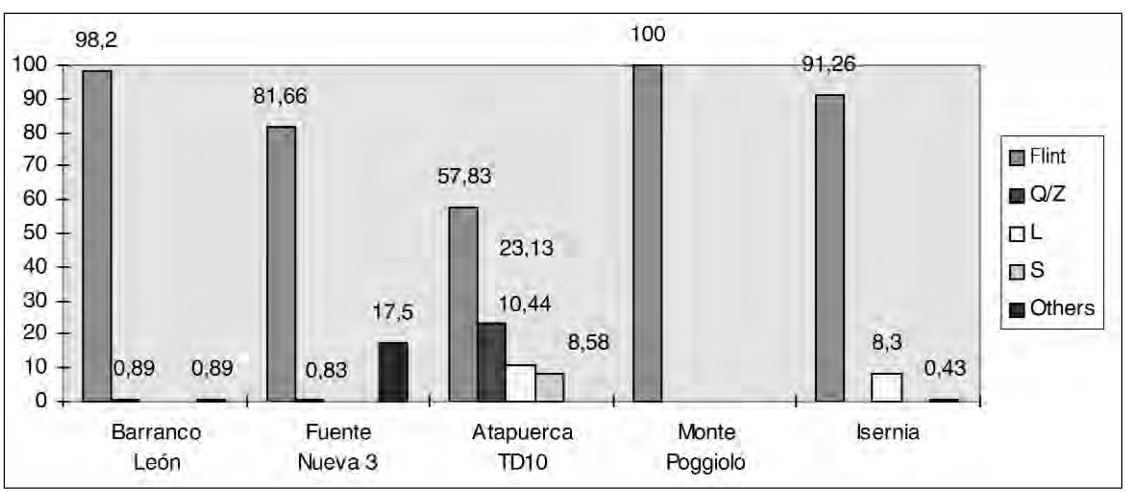
At Barranco León (located in the distal area of an alluvial system) and Fuente Nueva (in a lacustrine environment), almost all the transformed implements (excluding, then, the referred manuports) are made of high quality flint. At the first site, the grayish flint recovered has a Jurassic origin and its outcrop source has been identified two km. to the northwest. The Fuente Nueva siliceous variety has a white color and occurs four km. from the archaeological site (Gibert *et al.*, 1998b: 23). The two quartzite pieces (one at each site) probably have a more remote origin, in the gravel deposits to the north (six to eight km. away).

Atapuerca TD6 exhibits the highest variety of rock types selected, all of them available from no more than three km. away from the site (Mallol, 1999). Flint and quartzite, in this order, are the best-represented materials. Flint appears in two different forms: a Neogene flint from the marls located at the south of the Sierra and a Cretaceous flint related to the karstic system. All varieties of metamorphic rocks, including the quartzite cobbles used, come from the terraces of the Arlanzón River that borders the Sierra to the south. Flint and quartzite play an important role in the assemblage composition and are the main materials selected not only in the reduction sequence, sometimes flaked in an exhaustive manner, but also in the retouch activities. The relatively important presence of limestone, a ubiquitous material in the Sierra, is the best example of a casual and *ad hoc* selection of blanks for flaking purposes.

The Monte Poggiolo lithic collection is produced entirely from flint. Siliceous rocks naturally occur in the archaeological area, which, as already mentioned, is located in fluviatile gravels rich in flint and limestone cobbles (Antoniazzi & Piani, 1992: 241). However, petrographic studies suggest that the siliceous materials selected belong to at least two heterogeneous rock types that could have different origins. Therefore, more varied procurement sources than the very local river delta channels may be possible (Peretto *et al.*, 1998: 361). In addition, there is not a clear relation between the two different flint types and specific reduction strategies. It seems that the flaking processes have been equally intense regardless of cobble quality.

The main rock type used at Isernia is flint. Its origin is local and comes from the outcrop of an eroding formation less than two km. from the site. The siliceous material appears as small blocks (less than 10 cm.) that can be related to two different varieties (Sozzi *et al.*, 1994: 51): the first is fine-grained and has an homogeneous texture; the second is a brecciated, coarse-grained and lower quality type, often showing fissures and weakness planes in its structure. The second important raw material is limestone. This rock has also a local origin and comes from the alluvial outcrops located in the vicinity of the archaeological site. Generally the angular limestone cobbles selected exhibit larger dimensions than the flint utilized (the length of the limestone specimens can reach 20 cm.). Difference in shape, dimension and quality between flint and limestone correlates with different selection and use (and therefore, in their contribution to the specific categories). While the flint

Figure 3



3. *Percentage of raw materials used in the assemblages under study (Flint; Q/Z, quartzite and quartz; L, limestone; S, sandstone).*

shows a low, non-intensive level of reduction (i.e. cobbles with few or isolated scars and pieces that fit in the range of the traditional “chopper” typological group), the limestone is intensively flaked and much more involved in the reduction processes.

Knapping Processes

Cores and Reduction Strategies

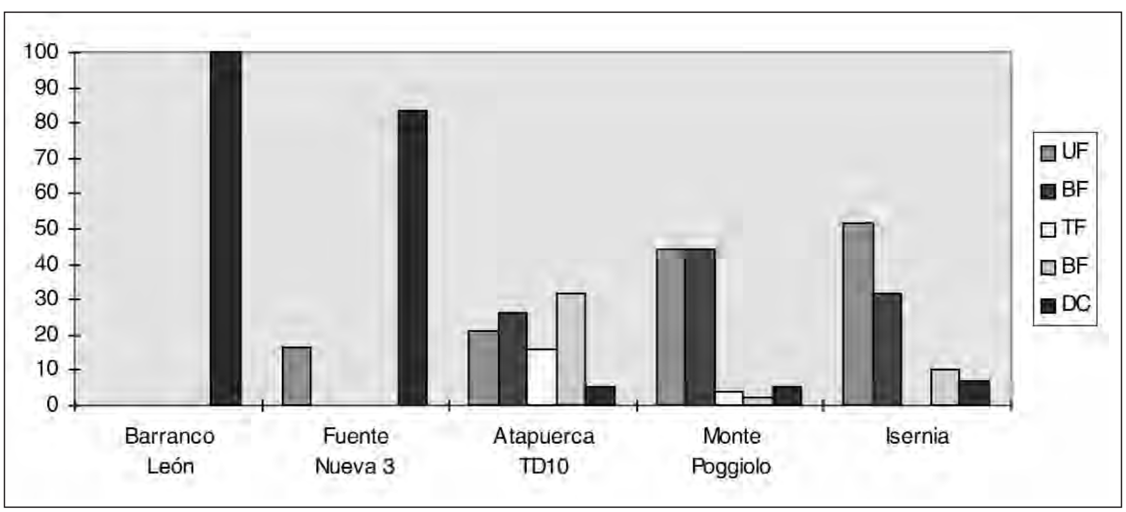
Although in every assemblage the core class tends to be of a Mode 1 nature, there are significant differences among sites in terms of the qualitative information available (table 2, figure 4). For instance, at Fuente Nueva and Barranco León cores are scarce and exhibit homogeneity in the reduction processes performed (Gibert *et al.*, 1998b: 21). In both localities, almost all the cores have been exploited in a centripetal manner, although one of these pieces, from Fuente Nueva, shows a laminar tendency (at least two laminar scars can be recognized). The only exception to this discoid tendency is a small quartzite “chopper-core” from Fuente Nueva, which shows simple unifacial exploitation. These flint cores are of small size, particularly in the case of Barranco León. Taking into consideration the fact that most of the flakes recovered at both sites tend to be larger than the cores, it seems clear that these cores can be considered exhausted nuclei.

At Atapuerca several reduction patterns are present, the unifacial and bifacial being the most representative. Most cases (68% of the cores) exhibit the orthogonal technique (by which the flakes are detached using an angle close to 90º). Depending on the raw material selected, the orthogonal method involves one or two faces (on fluvial materials) or multiple faces (on flint). It has been suggested (Carbonell *et al.*, 1999a: 664) that the Neogene flint blanks were introduced in the cave partially reduced, as no cortical flakes of this material have been found in the locality. This hypothesis seems plausible, taking into consideration that the big cobbles found outside the cave should have been flaked with anvil technique to detach smaller pieces. Only one discoid core has been recorded, a quartzite piece with centripetal scars, but some morphological features observed in a number of flakes in Cretaceous flint (ie. radial scars on dorsal surfaces along with faceted platforms) suggest that centripetal exploitation was widely used on flint.

Cores at Monte Poggiolo have the highest value of all sites considered. While in the past all cobble cores at this site tended to be classified as chopping tools, today these objects are seen as examples of an opportunistic reduction sequence (Peretto *et al.*, 1998: 362). Most of the nuclei exhibit simple reduction patterns (mainly unifacial and bifacial) and a small number of scars, which has been related to a fairly low degree of reduction. In fact, among the unifacilly flaked cobbles, 20% show only one scar. The other reduction patterns (ie. multifacial or discoidal) appear in much lower numbers and, unlike the simple reduction cases already cited, represent exhausted residues of a more intense reduction.

At Isernia, the use of both bipolar and direct percussion techniques has been reported. Bipolar technique was suitable to reduce the small flint cobbles, whereas direct percussion was employed to reduce the limestone blocks. Due to the use of bipolar technique here (with hard-hammer percussion more dominant at other sites), the cores present an important variety of morphological types that, nevertheless typologically fall within a range of unifacial and bifacial cores with discoid pieces being rare (Crovetto, 1994: 247-248).

Figure 4



4. *Percentage of core types by facial patterns in the assemblages under study (UF, unifacial; BF, bifacial; TF, trifacial; MF, multifacial; DC, discoid).*

Débitage

Débitage (flakes and debris) is the most abundant category in all the assemblages. The technical features observed in débitage are related to the reduction strategies carried out in the different sites, with very little preparation of cores evident. The casual knapping patterns reported at Monte Poggiolo are associated with flakes produced in the early stages of reduction (cortical and semi-cortical dorsal surfaces are abundant) and with simple platforms. Consequently, most of the platforms represented are cortical (30%) or plain, i.e. single scar (45%). Whereas the core assemblages of Fuente Nueva and Barranco León, as already mentioned, must be considered exhausted, the morphology of the flakes recovered at both sites show that they preferentially come from a non-prepared core technology (cortical and plain platforms are predominant in flakes). This indicates that a more intense reduction is observed at these sites than at Monte Poggiolo, as most flakes show non-cortical dorsal surfaces. This pattern of exhausted cores at these two sites seems to be a function of the higher quality flint being worked. One of the most remarkable aspects related to the flake assemblage from Atapuerca is its homogeneity in size regardless of raw material type (Carbonell *et al.*, 1999a: figs. 11-16). However, some other morphological characteristics do vary according to the type of rock selected. Flint flakes, primarily made from Cretaceous cobbles, do not show traces of cortex in their dorsal face or platforms, which is consistent with the interpretation that the early stages of knapping were performed outside the cave. Quartz and quartzite flakes, in contrast, are more representative of all different stages of the reduction sequence.

At Isernia, as the experimental work shows (Crovetto *et al.*, 1994), the knapping technique employed has played a very significant role in the flake morphologies. First, the large number of small flakes and angular fragments appear to be the result of bipolar technique. In addition, the flakes produced tend to repeat the same morphological pattern: they exhibit non-cortical dorsal faces (only 5% of the flakes are totally cortical, while 58% are completely non-cortical) and non-cortical platforms, which sometimes are shattered (Crovetto, 1994: 193-194).

Retouched Pieces

All the assemblages considered here include a number of retouched specimens. It is worth pointing out, however, that, although from a typological perspective and for classificatory purposes, all these objects are included in the same 'retouched' category, at some sites they do not appear to represent an intentional modification of natural edges.

Barranco León and Fuente Nueva have provided a considerable collection of specimens included in the retouched class. Most of these flakes have been defined as trimmed pieces (Martínez-Navarro *et al.*, 1997: 618; Oms *et al.*, 2000), in which the modification of the edges is shallow and marginal and probably due to utilization (although no use-wear analysis has yet been carried out to confirm this). More traditional retouched tools (classified as notches, denticulates and side scrapers) are present in small numbers.

Retouched tools are very rare at Monte Poggiolo. Twelve pieces exhibit traces of simple retouch of their edges. Although these objects have been characterized as denticulates (7) and side scrapers (5), their placement within such formal retouch types is problematic because of the crude and coarse character of the retouch (Peretto *et al.*, 1998: 361).

At Atapuerca, 60% of the retouched pieces are made on flint. The type of retouch observed is mainly simple (along one edge), fairly invasive, and unifacial (Carbonell *et al.*, 1999a: table 5) and does not show the more formal morphologies. Thus, many of the retouched pieces exhibit a sporadic/casual and discontinuous retouch (38%) that cannot be formally typed. The remaining retouched pieces have been classified as denticulates (34%) and scrapers (28%).

The category of retouched pieces described at Isernia is interesting in being far more varied than at the rest of the sites considered here. It includes the traditional retouched flakes, as well as retouch on fragments, small cobbles, cores and plaquettes (Crovetto, 1994: 228-229). Most of these pieces exhibit edges modified into denticulates (up to 90% among the flint retouched pieces), which tend to be coarse and non-systematic. Only in rare instances is it possible to find continuous (although sinuous) retouch, that would generally be typed in a scraper class (1.5%). Considering the nature of most of the pieces and that most of the retouch is denticulated, most of the retouched pieces at Isernia are generally placed within classical types of denticulate scrapers, end scrapers, *becs* and Tayac points.

However, experimental studies (Crovetto *et al.*, 1994) have been able to replicate most of the technical and morphological features observed in the archaeological assemblage and explain the way in which "retouched pieces" were produced. When flint blocks were placed on an anvil and repeatedly struck forcefully with a hammerstone until the core is exhausted, a recurrent pattern emerged: many of the artifacts produced (flakes, chunks, and cores) had the appearance of coarse and non-systematic denticulates, thick carinated scrapers, *becs* and end-scrapers. These results, which replicate very closely the features observed in the archaeological collection, led to the conclusion that the Isernia retouched pieces are for the most part not intentionally shaped but rather the accidental by-products of the bipolar technique employed (Crovetto *et al.*, 1944: 151). Thus, the category of retouched objects at Isernia is likely very over-represented. Only flat scrapers with a continuous retouch could be regarded as retouched tools *sensu stricto*, which means 0.6% of the total assemblage would fall into a retouched tool category (a percentage substantially lower than that obtained by typological means).

Tool Use: Use-wear Analysis

Samples of artifacts have been studied at Atapuerca, Monte Poggiolo and at Isernia in order to search for microwear evidence. At Atapuerca a sample of 24 out of 43 artifacts that were examined for microwear exhibit traces of use. However, functional interpretation has been possible for only 17 specimens, including 9 pieces inferred to have been used on meat, 5 on wood, 2 on bone and 1, possibly, on hide (Carbonell *et al.*, 1999a: table 3). Although flakes were mainly used to work on soft tissues, and denticulate pieces performed tasks on hard matter, this is admittedly a small sample and there is no clear-cut evidence of functional specialization among different typological groups.

Monte Poggiolo has provided a sample of 27 utilized flakes. Working edge angles are predominantly acute (42%) and simple (34%). It has been possible to identify microwear patterns on 21 artifacts with regard to material worked. Ten pieces exhibit traces of use on soft animal biomass and have been related to butchery activities. Traces on the other pieces have been interpreted as produced by working on vegetal tissues (wood in six cases and an unidentified grass in the other four). Microwear on the remaining artifact has been related to scraping activities on an undeterminate hard material (Peretto *et al.*, 1998: 454).

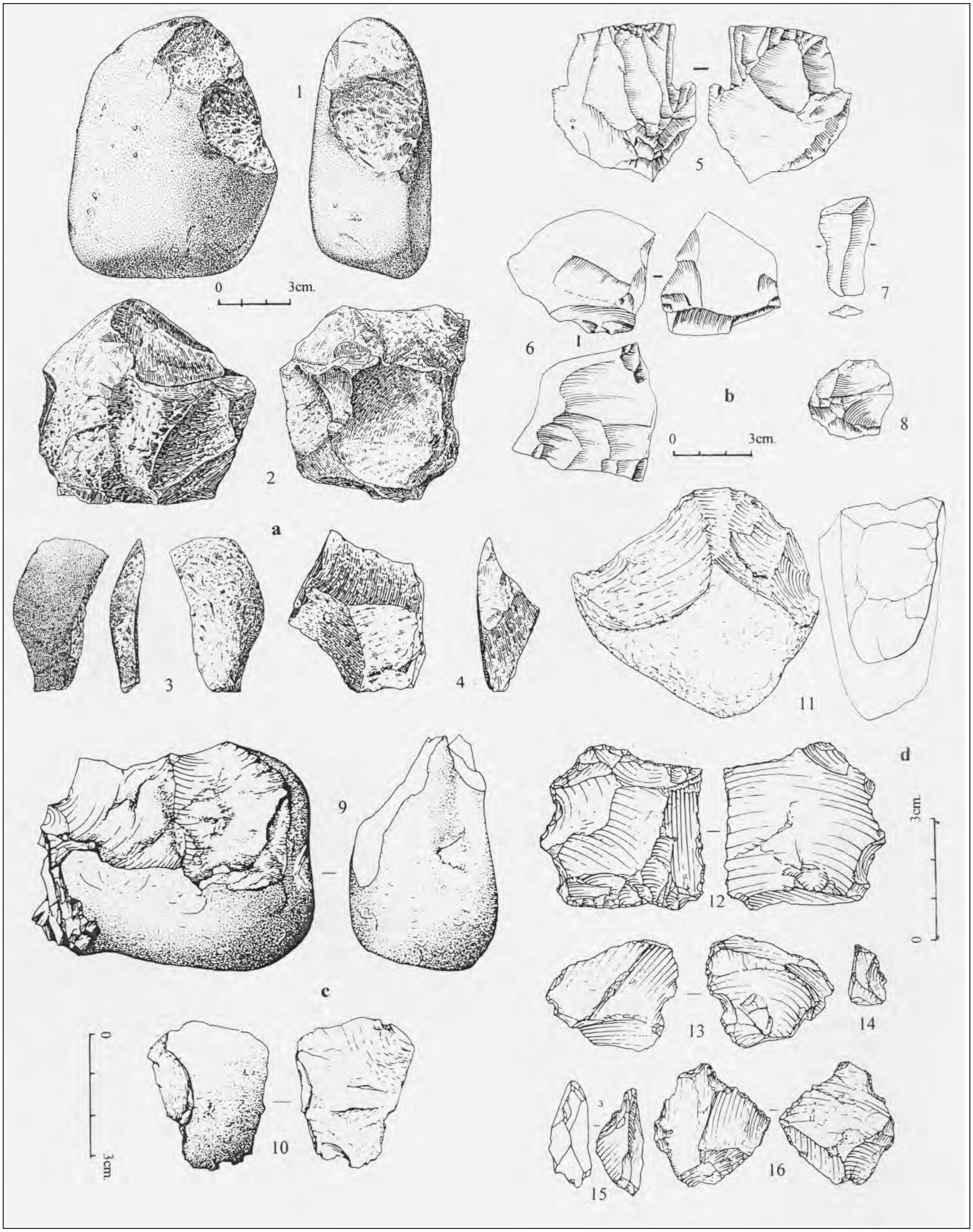
At Isernia a sample of 218 flakes from sector II have been analyzed. It includes 134 unmodified flakes and 84 denticulate pieces (some of them, from a typological perspective, classified as *becs*). The result of the investigation shows that those carinated objects with a denticulate retouch do not present traces of microwear, which seems to be in agreement with the interpretation provided by the experimental studies (i.e., they simply are the by-products of the bipolar reduction strategies). Only the non-retouched flake group has provided traces of use. In these cases, the working edge angle is very acute. Micro-retouches and micro-fractures affecting natural edges have been found in several pieces, a pattern that has been interpreted as damage produced by use. In addition, traces of polish have occasionally been found in some specimens, which suggest that the flakes were used only briefly (Longo, 1994).

Summary of Technological Traits Observed in the Earliest European Lithic Assemblages

Available data about the lithic assemblages of Barranco León, Fuente Nueva, Atapuerca TD6, Monte Poggiolo and Isernia can be summarized as follows (figure 5):

1. In general, most raw materials selected always have a local origin. All the rocks are easily found in the vicinity of the archaeological sites, in a range of less than 4 km. At Barranco León and Fuente Nueva it is possible, however, that quartzite cobbles used have a more distant origin. To confirm this second pattern, it would be necessary to improve knowledge about the surrounding catchment areas.
2. Furthermore, in most cases, the types of rock selected are not diverse and tend to have been used according to their overall relative frequency in the site area, which seems to have been the most important factor in procurement strategies. Atapuerca is an exception, although no specific selection of rocks according to texture quality is observed.
3. Although there is no particular selection of raw materials, it is worthwhile to remember that reduction strategies, blank dimensions, and raw material quality have been major factors determining the final morphology of the cores and flakes. For instance, flint at Fuente Nueva and Barranco León is of good quality while the small flint cobbles from Isernia often show fissures and weakness planes.
4. Cobbles and blocks have been reduced using hard-hammer, bipolar or throwing percussion techniques. Knapping was carried out at the sites, although at Atapuerca, some of the early stages of the flint reduction sequence were carried out at the quarry, outside the cave system.
5. Cores show patterns of non-systematic and opportunistic reduction. This appears to be the case particularly at Monte Poggiolo and Isernia, where *ad hoc* percussion techniques were predominant. The non-systematic character of these objects is supported by the lack of prepared platforms. At most sites, unifacial and bifacial reduction models, generally showing a low degree of reduction, predominate. Multifacial and discoid methods are present in low numbers. However, Barranco León and Fuente Nueva show a different pattern. In both cases, the core assemblage consists of exhausted discoid specimens and, considering the fact that the core category is poorly represented, it should be pointed out that only the final stages of the reduction sequence are present.
6. Flake production seems to have been the main goal of the craftsmen. Flake morphologies indicate non-systematic reduction systems and tend to exhibit the early stages of the reduction sequence (cortical and sub-cortical dorsal faces, cortical and plain platforms). Again, specific raw materials introduce variations to this pattern: in Atapuerca, unlike fluvial rocks, flint flakes tend to be non-cortical, while non-cortical flakes are predominant at Barranco León and Fuente Nueva.

Figure 5



5. *Lithic industry. a. Atapuerca TD6: 1. limestone core-chopper; 2. Neogene flint core; 3. quartzite flake; 4. Neogene flint flake; b. Fuente Nueva 3: 5 and 6. cores; 7. flake; 8. trimmed flake; c. Monte Poggiolo: 9. core; 10. flake; d. Isernia: 11. limestone core-chopper; 12, 14 and 16. denticulates; 13. notch; 15. burin. (adapted from Carbonell* et al., *1999a; Martínez-Navarro* et al., *1997; Peretto* et al., *1998; Crovetto, 1994).*

7. The retouched tools are relatively few. They include casually trimmed and discontinuously retouched pieces and other flakes that can be assigned (though not unproblematically) to more classical types. Most of these types are denticulates and side scrapers. The retouch tends to be coarse and crude, sometimes invasive, and simple. Thus, retouched tools seem to be part of the same opportunistic strategy performed in the block reduction processes. Small format tools with specific and recurrent edge morphologies do not seem to have been an objective.

8. Taking into consideration all these technical and morphological characteristics, the lithic assemblages considered fall within the range of Oldowan-like Mode 1 technologies, as described by Clark (1977: 23).

On the Meaning of the First European Mode 1 Technologies

While there is a broad consensus that the technological traits observed in the oldest archaeological occurrences of Europe *formally* can be related to the characteristics first seen in the African Oldowan technocomplex (Ludwig & Harris, 1998; Schick & Toth, 2001) or to Mode 1 (using a generic terminology, perhaps more appropriate for these non-African cases), less agreement exists at the *interpretative* level. Nowadays there are two main different positions addressing this question, which, not surprisingly, tend to follow the two theoretical spheres represented by the short chronology and the mature Europe hypotheses.

The first perspective (closer to the mature Europe scenario) interprets these occurrences as, in a literal sense, pre-Acheulean technologies. Mode 1 assemblages at these first sites could be considered to have some sort of discrete *cultural* background and might be linked, in some ways, with the Oldowan "tradition". This view, which assumes that similar techno-typological traits indicate cultural relationships of some kind, is deeply rooted in the European Paleolithic (Otte, 1996: fig. 116). The European archaeological record for many decades has yielded Lower and Middle Pleistocene assemblages consisting of crude cores and flakes without handaxes or cleavers. Recurrently, these sites have been interpreted as part of a pebble tool culture with an African Oldowan origin that developed separately from and contemporaneously with the Acheulean (a good example of this view can be found in Tieu, 1991). A more recent perspective could indirectly support this cultural-historical interpretation. Some authors (Foley, 1987; Foley & Lahr, 1997) have suggested that human technology can be read from a phylogenetic point of view and that technological patterns reflect patterns of human biological evolution and dispersal rather than cultural connections. This view could be summarized in the assertion "one species, one technology."

Unfortunately, the relation between specific human groups and certain technologies is an idea that does not seem to match the archaeological evidence (ie. Cosgrove, 1999; Bar-Yosef & Kuhn, 1999). Most scholars agree that Paleolithic technological variability is a much more complex phenomenon and that a number of different factors can be involved in conditioning the traits observed in any assemblage (i.e. raw materials, ecological constraints, type of occupation). The influence of those factors should serve as a caution for those who infer cultural affinities of this sort, especially considering that early European Mode 1-like assemblages occur well after the origin of Mode 2 in East Africa at about 1.6 Ma.

From the short chronology perspective, this framework is used to point out that early European Mode 1 industries should be interpreted from a para-Acheulean rather than a pre-Acheulean perspective and that the lack of large flake bifacial tools, is due to several factors, some of them simply adaptive, not related to any specific cultural background or connection. This discussion shares some similarities with the debate about the meaning of Mode 1 industries in East Asia (Schick, 1994: 586-591). In the European case, workers have paid attention mainly to the following aspects (Rolland, 1992: 88): 1) taphonomic effects combined with small sample sizes, 2) raw material constraints, and 3) specific site function. However, although all these factors must be regarded as relevant in any lithic collection, none of them provides conclusive explanations for the absence of Mode 2 features in the earliest European occurrences.

With regard to the first of these factors, it should be stressed here that the available early European lithic collections are sparse and may not adequately represent the full range of prehistoric technological features at these sites. Due to intense geomorphologic dynamics in European Quaternary deposits (i.e. periglacial and fluvial forces involved in sorting and reworking materials) it might have been difficult to preserve most of the archaeological remains, which inevitably would lead to sample bias (by which bifacial tools might be lost from the ancient sites), although it is important to note that preservation biases affect the entire Pleistocene sequence and they do not appear to be an insurmountable obstacle to recover Middle Pleistocene large tools. This particular problem is well exemplified at the South African site of Sterkfontein, as has been recently reported (Kuman, 1998: 177).

While this concern does not apply to the Italian sites studied here (for both of which the archaeological collections are abundant), it certainly must be kept in mind in regards to the Spanish record. Orce Basin assemblages are regrettably meager. For instance, the 120 artifacts recovered at Fuente Nueva actually belong to four different aggregates, the largest in stratigraphic context being a collection of only 49 artifacts found in level 2 (Oms *et al.*, 2001: tab. 1). Barranco León has provided the largest sample so far, a homogeneous archaeological sample of 107 pieces. Atapuerca TD6 is, as already noted, a 6 m^2 test excavation and therefore, the 268 artifacts recovered represent only a preliminary indication of its potential richness (which will be fully uncovered when the extensive excavation over an area of 80 m^2, now in the lower part of TD10 level, reaches Aurora stratum). However, assuming that the final lithic definition still has to be completed, the relatively high lithic density (45 lithic objects/m^2 and, considering the entire archaeological and paleontological assemblages, more than 743 items/m^2) provides a more reliable sample.

The second factor, the influence of raw material, has been repeatedly cited as an important factor of variability and a possible influence on the final techno-typological appearance. It has been pointed out, for instance, that the crudeness seen at Isernia is due to the poor quality and small dimensions of the raw material available in the surrounding area (Mussi, 1995: 40). While rock quality may account for the technological pattern in this case, it is more difficult to consider its relevance in the other sites. High-quality flint was selected at the Orce basin occurrences, while at Monte Poggiolo the size or quality of the raw material does not seem to be related to the opportunistic lithic production. At Atapuerca the same variety of raw materials (and in similar proportions) is selected and used to produce the Mode 1 industry from TD6, the Mode 2 industry from Galería and the Mode 3 industry from TD10-11 (Carbonell *et al.*, 1999a: fig. 19). It should be kept in mind, additionally, that raw material influence in reduction processes has been generally overstated. As several studies demonstrate (Moloney, 1996; Brantingham *et al.*, 2000), almost every lithic feature can be obtained using any type and quality of raw material. It could be expected, then, that some Mode 2 "progressive signs" might have emerged and been noticed in these lithic assemblages.

With regard to the third factor, ecological and functional aspects might also provide some clues relative to the composition of the early assemblages where handaxes are not found. As has been pointed out, Mode 1 tool-kits "represent opportunistic, least effort solutions to the problem of obtaining sharp edges from stone" (Isaac, 1981: 184). Using this perspective as a reference background, the occurrence of Mode 1 collections after the origin of the Acheulean techno-complex could be interpreted as efficient solutions serving multiple tasks when a mere *ad hoc* technology was sufficient. The interpretation of the lithic assemblage of the German site of Miesenheim I illustrates the use of the "least effort functional hypothesis" to explain European Mode 1 collections. Dated to around 450-400 Ka, when biface occurrences appear to be present in the continent, it exhibits a production of simple cores and flakes. This opportunistic tool-kit has been interpreted as an effective response to a human activity dominated by a secondary scavenging of carcasses obtained by carnivores (Turner, 1999b: 380).

Whether or not this case can be used to explain the lack of handaxes in the earliest European lithic assemblages remains uncertain, because we do not understand the functional meaning of handaxes well enough to explain the dichotomy "handaxes *versus* cores and flakes" in terms of site function. For instance, handaxes have been related to large mammal meat access (Jones, 1980; Toth, 1982), as several archaeological cases show, such as the elephant butchery sites of Áridos and Ambrona in Spain (Santonja *et al.*, 1980; Santonja *et al.*, 1997) or Boxgrove in Britain (Ashton & McNabb, 1994). On the other hand, a similar association of large mammal remains and non-bifacial tool-kits covering a broad chronological and geographical range has been reported, for instance at the Ethiopian site of Gadeb (Clark & Kurashina, 1979: 38) and the Italian localities of Isernia (Giusberti & Peretto, 1991) and Notarchirico A-B (Piperno *et al.*, 1999: 86-106). (A comprehensive summary of African and European Pleistocene archaeological sites related to elephant access can be found in Martos-Romero, 1999). This evidence is in agreement with experimental data showing the functional versatility and success of Mode 1 repertoires (Toth, 1987).

Another interesting approach has stressed possible differences between both technologies in terms of specific responses to landscape mobility and use. Recently, two cases have been reported in Africa showing this pattern within the Acheulean complex time span. In the Ethiopian Eastern Middle Awash, Mode 1 and 2 industries co-occur occupying different environmental settings. Mode 1 assemblages are recovered in stable floodplains, whereas Mode 2 assemblages are related to high-energy tributary streams (Clark & Schick, 2000: 67). At Peninj (Tanzania), Mode 1-like assemblages are located in the floodplains near the ancient lake margin while Mode 2 assemblages are located away from the lake and close to fluvial contexts (Domínguez-Rodrigo *et al.*, 2005). In addition, at Peninj, Mode 1 assemblages are located in patches whereas Mode 2 occurrences seem to be more scattered. Both of these cases may represent the patterning of distinct technological behaviors in response to different geographic and ecological locations, already observed in the earliest Acheulean of Olduvai Bed II (Hay, 1976: 181).

The European example of this "ecological hypothesis" for the Mode 1/Mode 2 co-occurrences (after Domínguez-Rodrigo *et al.*, in press) is represented by Keeley's work (1980). Studying the geographical distribution of handaxes in Britain, he concluded that the sites with bifaces, multitask tools he suggests, could be related to economic activities (hunting and gathering) carried out away from the home bases, where a higher proportion of débitage and small tools should be expected (*ibid.*: 161). From this perspective, Ashton (1998) has recently proposed his "static resource model" to explain the way in which lithic assemblages could vary in terms of biface/non-biface presence. He argues that this dichotomy should be explained as a response to environmental differences, mainly local resource availability.

If this view is correct, differences between Mode 1 and Mode 2 assemblages would simply reflect specific technological responses to the variety of locations and specialized activities that occur within the group's home range. However, in the European context, this hypothesis has not yet been demonstrated to be consistent enough to suggest that the opportunistic technology seen at the earliest European sites is due mainly different activities at different locations. (It would, of course, be necessary to explain why early European settlements show such a homogeneous technological response in different locations and possibly with different activities). Although there are some well-documented Middle Pleistocene Acheulean sites related to task-specific activities, such as the cave site of Galería in the Atapuerca complex (Carbonell *et al.*, 1999b), regional-scale studies available do not confirm a clear pattern of technologies related to specific tasks.

One of the most extensive and complete Middle Pleistocene landscape approaches in Europe is the long-term survey and excavation analyses carried out in the Duero River basin, in the Spanish Northern Meseta (Santonja & Pérez-González, 1984, 1997). Until recently, all the Acheulean occurrences reported in this area were found in the bank terraces of the fluvial system, mostly in lower sections of tributary rivers. This persistent fluvial location pattern led to the conclusion that both movements and settlements took place preferentially along fluvial environments (*ibid.*, 1984: 328). This perspective assumes that hominid home ranges (and presumably all the different site-types and activities related to them) were mostly restricted to these areas, in which handaxes occur homogeneously and no specific Mode 1-like/Mode 2 dichotomy is observed.

However, in recent years our understanding of landscape occupation patterns in this region has broadened, and we now know that the Tertiary high plateaus adjacent to the river valleys were also intensively occupied (Diez-Martín, 2000). Although this area, more than 100 m above the river valley level, is a distinctive ecosystem, no substantial difference has been found in the composition of the lithic assemblages in this highland area versus the fluvial setting, other than minor formal aspects related to constrains imposed by the access to raw material sources. In addition, the scatter and patches analysis developed in these geomorphologically homogeneous plateaus does not exhibit major differences in the composition of tool-kits between denser site locations apparently visited repeatedly and apparently visited sporadically.

Perhaps one of the most solid arguments supporting the idea that European Lower Pleistocene technology does not represent a distinctive entity is the fact that Mode 1-like assemblages and Mode 2 assemblages clearly co-occur during the Middle Pleistocene. If, as we know, Mode 1 technology is "time-transgressive" (Clark & Schick, 2001: 55) and overlaps with the Acheulean during a long period of time, then we could speculate that in fact the opportunistic pattern seen in the oldest European lithic assemblages must be due to some sort of ecological, functional/locational, or social (age or sex division) influences not yet defined (even though European archaeological evidence supporting this view is not conclusive, as discussed above). However, our large-scale knowledge of this particular issue is rather deficient.

Middle Pleistocene (post-500 Ka.) lithic assemblages without handaxes and cleavers are well known in Europe, in sites such as High Lodge (Roberts *et al.*, 1995), Bilzingsleben (Mania, 1995), Schöningen (Thieme, 1999), Vertesszölös (Dobosi, 1990; Kretzoi & Vértes, 1965) or Notarchirico E1, E, C and Alpha (Piperno, 1999; Piperno *et al.*, 1999). The nature of these sites and other related industries, commonly known as Clactonian, Tayacian or Taubachian (Otte, 1996), and their relationship with synchronous Acheulean has been the subject of a long debate and diverse interpretations (for instance and mainly referring to the Clactonian debate, Breuil, 1932; Ohel, 1979; Svoboda, 1987; Mithen, 1994). Recently some of these Middle Pleistocene flake industries have been included by a number of authors as mere variants within the range of the Acheulean . For instance, recent excavations at the British site of Barnham (Ashton *et al.*, 1994) have demonstrated that the Clactonian is contemporaneous with the Acheulean and that differences between them should be due to raw material availability variations across the landscape or over time (Wenban-Smith, 1998: 96).

Leaving aside the particular Clactonian case, in which archaeological work has provided a new set of explanatory options to consider (see the comprehensive critical review by White, 2000), the main problem concerning Middle Pleistocene occurrences lacking handaxes is related to their technological characteristics. Unfortunately, as has already been pointed out (Wenban-Smith, 1998: 93), the debate over these assemblages has focused on the presence/absence of bifacial tools, while other technological patterns related to the nature of the flake tool component have been ignored. More attention should be given to this specific question, in order to conclude whether or not, beyond the lack of bifaces, these Middle Pleistocene retouch strategies are comparable to the non-systematic and casual retouch reported at Monte Poggiolo or Atapuerca TD6, for instance. For this reason, it is difficult to fully accept the general statement that the only difference between Mode 1 and Mode 2 technologies is the absence or presence of bifacial artifacts (Villa, 2001: 119) and that, therefore, non-bifacial Lower and Middle Pleistocene occurrences share the same technological traits.

Reality may be far more complex, and it is suggested here (as a working hypothesis needing comparative analytic studies in order to be tested) that, some of the standardization patterns observed in shaping large bifacial, Mode 2 tools should have correlates in small flake tools in those assemblages. Analyzing Lower and Middle Pleistocene flake assemblages can provide broader information about their respective technological characteristics. Some data that could be used as a starting point and that might support this idea (or at the very least indicate that it is a research avenue worth exploring) would include the high quality of scraper retouch at High Lodge (Ashton & McNabb, 1992: 166), as well as the qualitative variety and diversity of retouched tools reported at sites such as Bilzingsleben (Mania *et al.*, 1999: 303), Vértesszölös (Krétzoi & Vértes, 1965: 80), Schöningen (Thieme, 1999: 181), Notarchirico Alpha (Piperno, 1999: 309) or Visogliano 13-39 (Abbazzi *et al.*, 2000: 1182), technological traits not seen in the earliest retouched tool assemblages.

The adaptive/functional explanations discussed above envisage a scenario in which the earliest morphological traits originated as responses to particular challenges produced *within* Europe. Another set of explanations relies on the possibility that those early Mode 1 assemblages could actually be showing, due to different reasons (not necessarily cultural), a distinctive technological behavior, brought from *outside* the continent by its first migrant populations. These perspectives are diverse and tend to explain this phenomenon in a variety of ways, not necessarily in agreement with each other. However, all of them stress the important role played by migratory factors and their influence in the technological behavior of the first Europeans. One of these perspectives, suggested by Toth and Schick (1993: 352), pointed out that populations exiting Africa and reaching Eurasia could have lost the Acheulean component of their technologies and could have returned to the use of Mode 1 patterns. Following their argument, while moving out of Africa, human populations could have had problems in finding suitable rocks to create large bifacial stone tools and, due to weak social and communicative networks or cognitive skills, they might not have been able to maintain their original Acheulean repertoire. This phenomenon, possibly along with other factors such as the adaptive modification of the Mode 2 tool-kit due to newly available materials such as bamboo (Schick, 1994: 587), would have been responsible for the spread of "Mode 1-like" assemblages in extensive areas of eastern Asia.

Taking into consideration that most consistent data for the oldest Asian occupation reaches back to about 1 Ma Schick & Zhuan(1993), Rolland, (1992) suggested that the first humans would have migrated to Europe via East Asia, moving along with animal dispersals and carrying with them their technological mutation, from a Mode 2 back to a Mode 1 industry. This Eastern Asian-European link seemed to be the only one possible, taking into account that the other areas surrounding Europe showed to have been first occupied with a Mode 2 technology: Ubeidiya in the Near East, dated between 1.5 and 1 Ma. (Bar-Yosef, 1994) and the Acheulean in the Maghreb, dated at about 1 Ma. (Raynal *et al.*, 1995).

The two viewpoints presented above assume that all archaeological sites found beyond East Africa, whether or not they look Acheulean and whatever the reason responsible for this fact, derive from a fully established Mode 2 industry. These perspectives are based on a scenario in which the first human traces out of Africa post-date the earliest Acheulean occurrences (ie. <1.6 Ma) ; (Schick & Toth, 2001: 70). The last years have witnessed a number of significant archaeological findings that have challenged (and in some cases been able to change) the established Out of Africa paradigm and have refreshed the debate on this issue. If we accept alternative data reported in Central Asia (Dennell *et al.*, 1988) and the Far East (Swisher *et al.*, 1994; Wanpo *et al.*, 1995), the first hominin radiation eastwards would be pushed back in time to around 2 Ma. (Turner, 1999a: 568), doubling the traditionally accepted chronology of first human expansion into this region. However, this evidence is controversial in the nature of the findings (the case of Longgupo cave, Etler *et al.*, 1997; Swartz & Tattersall, 1996) or disputed in the chronological results (Pakistan and Java cases, Hemingway, 1989; Klein, 1999: 271). Although a very early sortie out of Africa would be the perfect explanation for Mode 1 industries in large parts of Asia and the isolated *Homo erectus* evolution in this geographic *cul-de-sac* (Tattersall, 1997: 48), doubts concerning the validity of these very old chronologies necessitates putting this possibility on hold at this time.

With regard to the European case, more consistent examples supporting an early sortie Out of Africa and a pre-Acheulean presence at the gates of Europe have been found in North Africa and the Caucasus regions. The Algerian site of Ain Hanech (Sahnouni & Heinzelin, 1998; Sahnouni, this volume), bracketed by means of paleomagnetism and biostratigraphy within the Olduvai subchron (1.95-1.78 Ma.), has provided a rich collection of fauna associated with numerous Oldowan stone tools. At the Georgian site of Dmanisi (Gabunia *et al.*, 2000; 2001) an impressive collection of human fossils (three crania and 2 mandibles assigned to *Homo ergaster or Homo georgicus*) (Vekua *et al.*, 2002) has been associated with faunal remains and more than one thousand Mode 1 stone tools have suggested an age of about 1.85 Ma. for the occurrences. Although these data support the idea that humans reached the areas surrounding Europe before the origin of Mode 2 industries, it does not imply that the earliest European Mode 1 industries are directly descendant from these migration events. First, there is a significant chronological gap of almost one million years between the Algerian and Georgian sites the earliest European occurrences, and the European evidence does not seem to support a direct link with these early sites in Georgia and North Africa.

Some scholars have pointed out that early human dispersals during the Plio-Pleistocene transition into Eurasia may well have been sporadic, considering the lack of chronological and geographical continuity observable in the evidence currently at hand (Bar-Yosef & Belfer-Cohen, 2001). The present data seems consistent with a scenario in which hominins reached northern latitudes in diverse waves of intermittent trial occupations that possibly did not succeed. The same problem of an intermittent record may also be the case in North Africa. Such incursions could possibly have involved periodic incursions into Europe via Gibraltar or Sicily. Despite having been questioned for decades, such migration routes continue to be considered by a number of authors (Rolland, 1998; Bar-Yosef, 1998; Arribas & Palmqvist, 1999) and could be backed by other Early Pleistocene open-water crossing cases, such as the colonization of Flores Island by *H. erectus* (Morwood *et al.*, 1998). (A good critique to the Sicilian alternative, however, is provided by Villa, 2001).

More in agreement with the scenario of intermittent, non-continuous dispersals would be the hypothesis recently presented by Carbonell and colleagues (1999c). The authors argue that after the origin of Mode 2 industries in East Africa, some groups persisted in using Mode 1 patterns. Eventually, due to technological competition (Mode 2 would have been a more efficient response to environmental changes, adaptive requirements, or population pressure), Mode 1 makers would have been pushed out of African core areas and, shortly before 1 Ma, would have arrived in Europe bearing their non-handaxe tradition. Other authors have already pointed out the weakness of this proposal (Villa, 2001), although it seems that, leaving aside the absence of empirical archaeological evidence supporting this hypothesis, its main problem is related with the technological competition scenario. While it is obvious that Mode 2 exhibits a more complex technological and operative behavior and as a result, probably, more complex social networks (Kohn & Mithen, 1999), its functional and adaptive advantages need to be clarified (as already mentioned in this paper) in order to explain such a powerful displacement of supposedly contemporaneous Mode 1 producers.

Nevertheless, this hypothesis deals with an interesting idea that has been largely ignored by most scholars. It is generally assumed that the invention of Mode 2 technology marks a powerful *terminus post quem* boundary (or the starting point of a distinct period), beyond which handaxe production would have rapidly generalized. However, it seems more likely, as already pointed out (Bar-Yosef, 1998: 227), that such an innovation process might have been slower. Factors like conservationism, geographical distance/isolation (Clark, 1961: 23-24) or cultural identity (the idea of social boundaries and resistance based on cultural identity is a pertinent — although largely unexplored — issue in this discussion, as is shown in modern human groups by Barth, 1969) might have been responsible for a more diverse technological picture after 1.6 Ma. Finally, we might also add to these factors, a possible intermittent radiation through North Africa, taking into account the affinities reported between the ancestral traits observed in the earliest European human fossils of Atapuerca and Ceprano and Middle Pleistocene African specimens (Aguirre & Carbonell, 2001; Manzi *et al.*, 2001).

Discussion and Conclusions

The scope of this chapter has been to present in some detail the technological traits observed in the oldest archaeological occurrences of Europe. At this point, however, to talk about the *earliest European technology* also requires addressing the question of what constitutes the first settlement of the continent. The issue of the first settlement of Europe has been a matter of debate for decades.

I have discussed above the different positions taken by European scholars on this issue since the 1990's, using some key publications that can properly exemplify the two major competing hypotheses in recent years: the short chronology and the long chronology perspectives.

Although in the last few years research has provided fresh data about the oldest sites and their technological patterns, the debate is still open. For instance, while the paper by Roebroeks and van Kolfschoten (1994) has been very important in creating a push for a more critical approach to the purported 'very old' European sites, it does not completely resolve ambiguities still existing in the record they dismissed. It is important to note that, although evidence from sites such as Vallonet, Soleihac or the Upper Duero river terraces have problems in their interpretation (e.g., in terms of chronology, taphonomy, or small lithic samples), it is still impossible to firmly reject them. The lack of better data at a number of sites does not necessarily render them useless in this debate. It only speaks to the fact that, we will need additional information in order to state whether or not these cases are relevant to the pre-500 Ka. occupation pattern.

In order to present the earliest European technological traits, the archaeological occurrences that in our current state of our knowledge seem more reliable have been presented above. These are Barranco León, Fuente Nueva 3, Atapuerca TD6, Monte Poggiolo, and Isernia la Pineta. I consider that current interdisciplinary investigations at these occurrences provide reasonably good geological contexts, reliable chronology, and a wealth of archaeological data that identifies these as bona fide prehistoric sites within the covering the 1.0-0.5 Ma time interval. Isernia should be considered the youngest example within this time range. A definite chronology for this site is still a subject of study and discussion, but its archaeological significance is inescapable as per the data cited above.

All five archaeological assemblages considered in this survey exhibit opportunistic and non-systematic reduction patterns that *formally* fit within the Mode 1 technological complex. Much can be said about the meaning of these features, and I would agree that some assemblages, especially Fuente Nueva and Barranco León, are too small to make a conclusive technological diagnosis. Bearing in mind this problem and awaiting further information, a significant portion of this paper has been devoted to discussing the meaning of the technological features observed in these occurrences.

Some interpretations for their Mode 1 appearance could lead to the conclusion that the patterns observed might be due to specific adaptive reasons rather than to a *sensu stricto* pre-Acheulean technology. Much attention has been paid in the last years to the functional/adaptive influence in lithic technological variability. This perspective has proven to be highly valuable in our understanding of some formal or stylistic patterns (i.e. the Lower-Middle-Upper European Acheulean technological divisions do not represent a linear evolutionary progression, as was previously thought). However, as has been suggested for the "Clactonian question" (White, 2000: 54), none of the cases cited in this paper seem to clearly demonstrate that Mode 1 traits observed in pre-500 Ka. sites are basically due to functionality, ecological constraints, or raw material availability. In order to support an explanation based on variability within a Mode 2 technology, more information needs to be compiled.

At present, different timings of human incursions into North and South Europe appear to be the most plausible scenario, and these should have played a key role in the characterization of the dichotomy observed before and after 500 Ka. To state that a *proper* occupation of the continent would not have occurred until human populations reached northern areas runs the risk of taking an inappropriate north-Eurocentric perspective and underestimates both the European geographical and ecological diversity and our present-day archaeological knowledge.

It is very important not to mistake data quantity for data quality. From the quantitative perspective, it is obvious that the wealth of archaeological sites after 500 Ka. marks a substantial shift in the information available. Nowadays, this is an unchallengeable archaeological fact. But there are some important, further implications that archaeologists can infer from this pattern. First, the dramatic shift towards an increase in the number of sites implies that the 500 Ka chronological boundary marks the time by which human populations had acquired the adaptive skills needed to survive in these northern latitudes of Europe on a more continual basis for the first time. Literally, this migration event can be referred as to the first *conquest* or *acquisition* of the European landmass by human settlers and their descendants: *H. heidelbergensis* and *H. neanderthalensis*. Furthermore, the sparse archaeological evidence prior to the 500 Ka boundary might inform us in important ways about skills and capabilities (e.g. adaptive skills or complexity of social networks) that the very first migrants might *not* have yet acquired to allow them to succeed in developing long-term settlements in the region.

If our intention is to reconstruct the culture history of the first human occupation of Europe at a continental scale and not just at specific regional scales, and also to fit this history within the long-term trajectory of hominid adaptations and colonization in the Old World (Roebroeks, 2001: 452), *both* the earliest incursions and the later, longer-term occupations necessarily complement each other, and both need to be taken into account. In this holistic framework, a number of connected questions can be posed: Within Europe, why did the Mediterranean region witness the first sparse traces of human occupation? Is it just a matter of proximity with other regions already occupied, i.e. North Africa, the Levant, or the Caucasus? Is it related to specific ecological reasons and/or geographical barriers? Why did the species involved in this occupation not succeed in terms of chronological continuity? What explains the ability of *Homo heidelbergensis* to settle and, literally, conquer the continent?

With the empirical data we do have, it is impossible to answer most of these questions and therefore provide a reasonable picture of the European migration events before the arrival of *Homo sapiens*. For obvious reasons, we are able to deal more comfortably with the post-500 Ka. occupation of Europe, and to provide a more complete set of explanations for the questions surrounding this phenomenon. A recent paper by Roebroeks (*ibid.*) summarizes the key reasons that might have allowed the permanent settlement of *H. heidelbergensis* in northern Europe, although his conclusions may also apply to the continent as a whole. It is important to keep in mind, however, that in omitting discussion of the earliest migratory pulse and its implications, we miss the opportunity to present a complete picture of this issue.

In sum, in our current state of knowledge available data (including the earliest hominin fossils from Atapuerca and Ceprano) suggest that the first human incursions into Europe, presumably sporadic and not completely successful, took place in the Mediterranean area before Mode 2 hominins spread throughout the continent. Although at present a clear correlation between the first arrival (or set of arrivals) and non-hand-axe occurrences can be established, the nature of this correlation is not properly clarified. It might be that we are seeing degeneration or drift away from original Mode 2 patterns due to mobility or social/cognitive constraints affecting earliest migrant groups, or some sort of technological continuity related to the first human presence in North Africa and the Caucasus and associated Mode 1 technologies. It is possible that we are just seeing a residual migratory example of the technological diversity present in Africa even after the origin of Acheulean technologies (with the co-occurrence of Mode 1). Whatever the case, it would seem reasonable to predict that, for the foreseeable future at least, questions surrounding the early migrations Out of Africa — their timing, their routes, and their associated technologies — will continue to play a major role in our understanding of the first European technologies.

Acknowledgments

This paper has been made possible thanks to the financial support provided by the Basque Government through its post-doctoral fellowship program. I sincerely thank K. Schick and N. Toth for accepting my stay and facilitating my work at the CRAFT Research Center, Indiana University and Friends of CRAFT, Inc. for critical logistical support and access to resources that enabled this study.

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