

5. Hunting and Hunting Weapons of the Lower and Middle Paleolithic of Europe

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Keywords Hunting • Western Europe • Mousterian points
• throwing and thrusting spears

Abstract This paper is a review of the state of our knowledge and ignorance on Early, Middle, and Late Pleistocene subsistence behavior in Western Europe. There are undoubtedly differences in subsistence behavior between early hominids and Upper Paleolithic humans in Europe. Yet recent research has shown that some of the most extreme statements about passive scavenging practiced on a regular basis at some Middle and Late Pleistocene sites are not supported by the evidence and must be rejected. We provide an overview of the hunting *versus* scavenging debate in African and European archaeology. We discuss the following issues: (1) evidence for hunting from the earliest sites in Europe, prior to 400–300,000 years ago; (2) evidence for hunting large mammals (elephants, rhinoceroses, large-size bovids) and for hunting/gathering very small vertebrates and invertebrates (leporids, birds, fish, shellfish) before the Upper Paleolithic; (3) evidence for the use of stone-tipped spears by Neanderthals in Western Europe.

Our analysis shows: (a) that for the period prior to OIS 12 (i.e. about 400ka) very few generalizations can be made about the subsistence behavior of early humans in Europe because the informative sites are few and far between. Nevertheless, a good case can be made for hunting from two of the earliest sites in

Europe, Gran Dolina TD 6 and Boxgrove; (b) even stronger evidence of hunting comes from sites such as Schöningen and later Middle Paleolithic sites where the topographic setting and the faunal accumulations indicate repeated episodes of hunting the same species of large-size mammals; (c) that Mousterian points were used to tip thrusting or throwing spears already by OIS 6 (i.e. between 186 and 127ka), before the end of the Middle Pleistocene. Implications for a correlation between hunting weapons and Middle Paleolithic faunal remains are discussed.

Introduction

In African archaeology, the debate about hunting or scavenging by early hominids has come full circle. It started about 30 years ago with some cautious assessment of hunting of small prey and possibly scavenging of larger carcasses (such as elephants and hippos; Isaac, 1978; Isaac and Crader, 1981) and continued with detailed analysis of the Olduvai (Tanzania) and Koobi Fora (Lake Turkana, Kenya) faunal assemblages by Henry Bunn (1981, 1982) who underlined the complexities of site formation processes and the multiple origins of various assemblages. He suggested that scavenging could have played a role in the subsistence behavior of early hominids, but that additional research was required to demonstrate the hypothesis. Bunn (1981) also provided direct evidence of hominid butchering practices with the occurrence of abundant cutmarks and percussion marks on bones from archaeological sites in the Koobi Fora formation and at FLK Zinj (Olduvai Bed I). The FLK Zinj site, dated to about 1.75Ma, has provided a large faunal

assemblage (more than 3,500 identifiable bone specimens with well-preserved bone surfaces) and has been the subject of more debates than any other site of comparable age.

At the same time, Binford (1981) strongly asserted that early hominids at Olduvai were marginal scavengers of bone marrow at large carnivore kill sites and had little access to meat. Several other researchers contributed to the debate with analyses and contrasting interpretations of butchering marks, the role of carnivores in site formation processes, and the archaeological signatures of scavenging and hunting (e.g. Potts and Shipman, 1981; Blumenschine, 1986, 1988; Blumenschine and Selvaggio, 1988). The debate intensified with an important paper by Bunn and Kroll (1986), which showed that abundant cutmarks and percussion marks occurred on meat-bearing limb bones (humerus, radio-ulna, femur, and tibia) of small and larger animal carcasses at FLK Zinj, proving that hominids had access to meaty elements. They concluded that carcasses had to be obtained either by hunting (hunting of smaller, gazelle-sized prey is consistent with trends in other primates) or by aggressive, confrontational driving away of primary predators or primary scavengers (cf. Bunn, 1996). According to Bunn and Kroll (1988), Binford's statements were wrong because they were based on preliminary and incomplete bone data that overrepresented lower limb elements, underestimated the abundance of meatier elements by excluding limb shafts, and did not take into account cutmark data.

The debate was not resolved because the evidence for early access to meat-bearing parts based on skeletal elements representation did not necessarily indicate who actually killed the animals. The debate was also complicated by discussions on the spatial distribution of bones and stones at FLK Zinj and other sites and on what behavioral model would best account for accumulation of artifacts and broken bones: the home base or central place foraging of Isaac (1984), the stone cache of Potts (1988), the refuge model to avoid carnivore competition of Blumenschine et al. (1994), or the near-kill model (O'Connell, 1997; Domínguez-Rodrigo, 2001).

The abundance of gnaw marks on the FLK Zinj bones (on about 400 bones, more than those with cutmarks, according to Bunn and Kroll, 1986) was an anomaly that would not fit actualistic data based on late access by carnivores. A multiple stage model was suggested by Blumenschine and colleagues, with large felids having primary access to carcasses, removing flesh partially or completely, followed by hominids who had secondary access and concentrated on marrow, and finally by other bone-crunching carnivores (hyenas) consuming the remaining epiphyses (Blumenschine, 1988, 1995; Domínguez-Rodrigo and Pickering, 2003 and references therein).

Experimental work by Domínguez-Rodrigo (1999) then showed that carcasses ravaged by lions provide very little edible tissue to hominid scavengers. Midshaft portions of upper limb bones (humerus and femur) display a complete lack of flesh scraps; flesh scraps are very poorly represented on midshafts of intermediate limb bones (radio-ulna and tibia). This is in contradiction with the evidence of abundant cutmarks on limb midshafts at FLK Zinj, as hominids would have no reason to use a cutting edge on a completely defleshed long bone (Pickering

and Domínguez-Rodrigo, 2006). Recently a re-analysis of tooth marks on the FLK Zinj assemblage has provided new lower estimates of carnivore modifications (Domínguez-Rodrigo and Barba, 2006). Moreover, most researchers agree that hyenas ravaged the FLK Zinj fauna **after** hominid involvement. All these observations suggest that hominids had early access to fully-fleshed carcasses, and were not relegated to the role of passive scavengers of marginal scraps of flesh and marrow from carcasses primarily consumed by carnivores, as proposed by Binford as well as in the three-stage model of Blumenschine and colleagues. Analysis of tool marks on the fauna from FxJj 50 (Koobi Fora, Kenya), from the BK assemblage in Bed II at Olduvai, from the ST site complex at Peninj (Tanzania), and from Swartkrans Member 3 (South Africa) also indicate that humans were significant actors in the formation of bone accumulations (Domínguez-Rodrigo and Pickering, 2003; Pickering and Domínguez-Rodrigo, 2006). The re-analysis by Oliver of the FLK Zinj assemblage (1994) had previously confirmed that there are more upper and intermediate limb bones with cutmarks than lower limb bones, like metapodials, with cutmarks (see also Dominguez-Rodrigo et al., 2007).

Thus the overemphasis on passive, marginal scavenging is rejected, Bunn's hunting/aggressive scavenging hypothesis is resurrected, and the role of humans in faunal accumulations at these early archeological sites is confirmed. Although this is unlikely to be the last word on the interpretation of the human role in faunal accumulations at East and South African sites, it is safe to conclude that the case for active hunting or confrontational scavenging, if we exclude sites with single carcasses of very large mammals, is now much stronger, and a flexible adaptation combining hunting and scavenging is a viable scenario for early humans.

The Hunting Versus Scavenging Debate in European Archaeology

In European archaeology the idea that scavenging was an important pattern of subsistence behavior of early humans was also suggested by Binford (1985, 1987, 1988), based on sites such as Torralba, Hoxne, Swanscombe, Vaufray, and Combe Grenal. According to him, the main activity represented at Torralba was scavenging of marginal parts left by carnivores of various non-elephant species. The predominance of head parts and feet (phalanges and lower foot bones such as metacarpals and metatarsals) was also cited as evidence of systematic scavenging at Middle Paleolithic French sites such as Vaufray layer VIII (with an estimated age of OIS 7,¹ approximately 200ka) and the Combe

¹Throughout the text we give ages as in Oxygen Isotope Stages (OIS) whenever possible. However climato-stratigraphic terms, such as Early Glacial, Würm, or Last Interglacial, are extremely common in European prehistoric literature and we use them if they are embedded in the literature cited; correlation of those climato-stratigraphic terms to OIS stages is not always automatic. The dates of isotope stages are provided in Klein, 1999: 59.

Grenal Würm 1 (i.e. OIS 5a–d or Early Glacial, approximately 115–75ka) layers. Binford thought that there was, through time, an increase in scavenging for meat; hunting became more common with the Early Glacial, but regular medium-to-large mammal hunting appeared (in Europe) only with fully modern man (Villa, 1990, 1991). This hypothesis of regular scavenging provided support to the idea that Neanderthals were behaviorally inferior to modern humans. Although both aggressive and passive scavenging are documented in modern hunter/gatherers (Bunn et al., 1988; O'Connell et al., 1988) scavenging by modern humans is not a systematic foraging strategy but an activity carried out in the context of hunting.

Later Stiner (1994) extended Binford's model, arguing that Neanderthals practiced a flexible and opportunistic passive scavenging mode, alternating with hunting. The case for scavenging was based on evidence from two Italian Middle Paleolithic sites, Grotta Guattari and Grotta dei Moscerini, both older than 55ka; each site contains several layers, some with assemblages accumulated by hyenas and others with assemblages accumulated primarily by hominids. According to Stiner, the ungulate faunas in layers accumulated by hominids are dominated by head elements. These are elements of low utility because they have little flesh and provide little nutrition (they have relatively high fat levels; Stiner, 1994: 266), but they are those available to non-confrontational, passive scavengers.

This hypothesis was widely accepted, but in a series of important papers Curtis Marean and colleagues (Marean and Kim, 1998; Marean and Assefa, 1999) have shown that the interpretations of scavenging proposed by Binford and Stiner are based on faulty data and should be rejected. Assemblages dominated by head parts are the result of systematic biases in recovery or analysis, due to discard of long bone shafts after the excavation or their neglect by analysts because bone shafts are less easily identified. Their omission causes an underestimation of meat-rich long bones and creates an artificial head-dominated pattern. As documented by Zilhao (1998), head-dominated or head-and-foot dominated patterns are not only characteristics of Middle Paleolithic sites but can also be observed in Upper Paleolithic and Neolithic sites (where

scavenging is not implicated), and are better interpreted as artifacts of taphonomy and excavation biases.

Mortality profiles with a bias toward old individuals have been described at Guattari and Moscerini. They have been considered by Stiner as complementing the skeletal element frequencies in favor of her scavenging hypothesis, because old individuals may have died a natural death, thus becoming available to passive, nonconfrontational scavengers. Since mortality profiles require a certain number of data points, we need to consider the size of the samples, their stratigraphic context, and accumulation process.

Several authors have pointed out that Guattari and Moscerini are very small assemblages, in addition to being heavily selected by post-excavation discard of long bone shafts (Klein, 1995; Gaudzinski, 1996a; Mussi, 2001). The stratigraphic sequence at Grotta dei Moscerini is 8m thick and the excavators described 44 sedimentologically distinct layers but, to bolster sample size, Stiner lumped the layers in six units: M1 to M6. The units with faunas accumulated by hominids (M2, M3, M4 and M6) are extremely thick, between 90 and 290cm, yet the samples are extremely small: M2 has yielded 39 NISP (Number of Identified Specimens), including bones and teeth; in M3 there are 361 NISP; in M4 159; and in M6 187. The density of NISP per liter of sediments, with an average of 32.4 lit. per one NISP (Table 5.1), is much lower than at other Mousterian sites. By comparison, in the Denticulate Mousterian of Saint-Césaire the density is 2.2 lit. of sediment per one NISP (Morin, 2004: 135); in layer 8 at La Quina the density of numbered bones (not counting the screen refuse) is 0.5 lit. of sediments per one bone (2,098/1000 lit.; Chase, 1999).

At Moscerini the excavators used dry-screening with a 5 mm mesh (Kuhn, 1990: 124), and apparently biases in selecting and keeping excavated items did not affect the stone artifacts. Yet the lithic assemblages at Moscerini (Table 5.1) are also quite small compared to other sites. The average density of artifacts in Middle Paleolithic cave sites of Northern Italy (e.g. Fumane, Tagliente) is between 5–10 lit. of sediments per one artifact; at La Chaise Abri Bourgeois-Delaunay (a cave site in the Charente region, France) where layers 10, 9, 8¹, and 8

TABLE 5.1. Grotta dei Moscerini and Grotta Guattari. Assemblages accumulated by hominids. Thickness of units measured from published section. NISP counts are for carnivore and ungulates (From Stiner, 1994: 50–56, 78, 247).

Site	Unit used by Stiner	Excavated area (m ²)	Thickness of the stratigraphic unit (cm)	Volume of excavated sediment (lit.)	Total NISP (bone and teeth)	Density (liters of sediment per one bone)	MNI of red and fallow deer	Stone artifacts	Density (liters of sediment per one artifact)
Moscerini	M2 (levels 11–20)	3	90	2,700	39	69.2	1	382	7.1
Moscerini	M3 (levels 21–36)	3	223	6,690	361	18.5	15	324	20.6
Moscerini	M4 (levels 37–43)	3	290	8,700	159	54.7	8	187	46.5
Moscerini	M6	<3	Unknown	Unknown	187	Unknown	7	196	Unknown
Guattari	G4	<25	Unknown	Unknown	53	Unknown	1 MNI of red and fallow deer and 2 MNI of aurochs G4–G5 combined	876	Unknown
Guattari	G5	<25	Unknown	Unknown	49	Unknown		482	Unknown

NISP = Number of identified specimens; MNE = Minimum number of elements; MNI = Minimum number of individuals.

dated to OIS 5 (hence comparable in age to Moscerini) were not screened, they have a density varying from 7.8–2.1 lit. per artifact (Porraz, 2005: 72; Delagnes, 1992: 23, 36).

The excavated area was only 3 m², corresponding to 5% of the preserved portion of the site; the very small size of the faunal and lithic assemblages compared to the thickness of the deposits indicate that the site was occupied only sporadically, and that these small assemblages are heterogeneous aggregates of materials accumulated over long intervals of time (Villa, 2004; Villa et al., 2005a).

The excavated area at Guattari is larger (Piperno and Giacobini, 1990–1991), but the assemblages from layers G4 and G5 (the assemblages accumulated by hominids) are even smaller, with 53 and 49 NISP respectively. Layers G4 and G5 occur at the cave mouth but thin out and disappear deep inside; their thickness and excavated surface are not provided in publications.

It is important to consider the minimum number of individuals (MNI) involved in Stiner's profiles in light of the problem of pooling of samples and cave sedimentation rates. At Guattari, in layers G4 and G5 the MNI of red and fallow deer is one, of aurochs is two. These numbers are too low and will not be considered further.

At Moscerini the MNIs used for mortality patterns (Stiner, 1994: 247, 302–305) are those red and fallow deer, the most common ungulates at the site. Stratigraphic unit M2 with only one MNI is 90 cm thick; unit M3 with 15 MNI is 223 cm thick; unit M4 with eight MNI is 290 cm thick; the thickness of M6 is unknown. Cave sedimentation rates are generally very low; 1 cm of deposit may represent from 5 to 167 years, with an average of 14 years (Speth and Johnson, 1976; Villa and Courtin, 1983). Clearly the Moscerini cave deposits represent very long time spans and probably many sporadic episodes of occupation. These very small and pooled samples of episodic behavior, spread over millennia and a large number of generations, cannot inform us on transport and subsistence patterns of the Moscerini inhabitants. It does not seem logical to treat aggregates of materials as if they were coherent assemblages with some measure of temporal and behavioral integrity. It is significant that in a recent paper Kuhn and Stiner (2006: 956) seem to agree that the question of scavenging by Neanderthals is a dead issue.

In conclusion, there is at present no evidence to support a hypothesis of systematic, regular scavenging activities by Neanderthals and earlier European hominids. In fact, the accumulated evidence from many Middle and Late Pleistocene Eurasian sites show that hunting, not scavenging, was the main method of meat procurement, and that in this respect Neanderthals and earlier humans in Europe did not differ from later, Upper Paleolithic humans (Villa et al., 2005a and references therein; Adler et al., 2006).

Reviewing the evidence for subsistence behavior in the Lower and Middle Pleistocene of Europe has led us to examine in detail two subjects for which there is still limited empirical evidence, and which have not yet attracted the attention of many archaeologists. In the first part we examine the evidence for hunting from the earliest sites in Europe. In the second part

we address a different question: if hunting, not scavenging, was the main method of meat procurement by Neanderthals, what kind of weapon did they use to dispatch their prey? Is there evidence for the use of stone-tipped spears in Western Europe?

The Earliest Sites

Only a small number of sites are securely dated to the Lower Pleistocene, just prior to the geomagnetic boundary between the Matuyama Reversed Chron and the Brunhes Normal Chron dated to about 780 ka ago (Klein, 1999: 51). Even fewer also contain faunas whose origins have been determined by taphonomic analysis. Some of the sites for which a Lower Pleistocene age has been claimed are either of uncertain age or contain no fauna (e.g., Monte Poggiolo), or the association of the lithic artifacts with the fauna is uncertain, and the role of humans in the accumulation of the faunal assemblage is unclear or undocumented. This is the case of Pakefield, Monte Peglia, Vallonet, Barranco León, Fuentenueva 3, and Sima del Elefante (Oms et al., 2000; Villa, 2001; Echassoux, 2004; Parés et al., 2006; Santonja and Villa, 2006 and references therein). The only exception is Gran Dolina TD 6 (Fig. 5.1, Table 5.2).

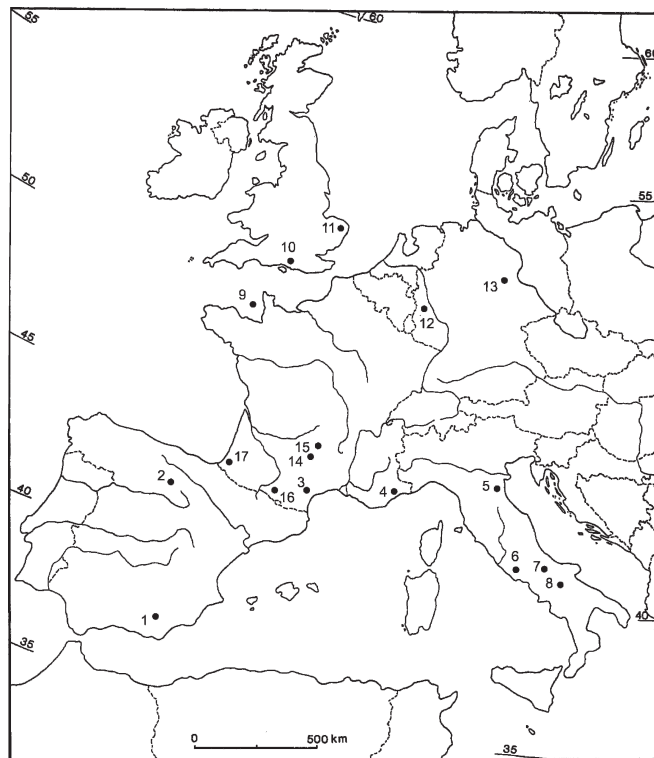


FIG. 5.1. Location of major European sites mentioned in the text. 1 = Barranco León and Fuentenueva 3; 2 = Atapuerca (Gran Dolina and Sima del Elefante); 3 = Arago; 4 = Vallonet; 5 = Monte Poggiolo; 6 = Ceprano; 7 = Isernia; 8 = Venosa Notarchirico; 9 = La Cotte de St. Brelade; 10 = Boxgrove; 11 = Pakefield; 12 = Miesenheim; 13 = Schöningen; 14 = Coudoulous; 15 = La Borde; 16 = Mauran; 17 = Bouheben.

The 18 m thick karstic fill of Gran Dolina begins with a series of levels (TD 1 and 2) with sediments typical of a closed cave. Level TD 6 (2.5 m thick) belongs to a second phase that corresponds with an opening to the exterior through an entrance which no longer exists because it was destroyed by railway construction at the end of the nineteenth century (Fernández-Jalvo, 1998; Pérez-González et al., 2001). The Matuyama/Bruhnes boundary is in level TD 7, 1 m above the top of TD 6, which is thus of pre-Bruhnes age. ESR and uranium series dates support this conclusion and suggest that the age of TD 6 is between 860 and 780 ka (Falguères et al., 1999; Bermúdez de Castro et al., 2004). The top part of TD 6, called the Aurora stratum, is about 20–25 cm thick and is made of silty clay with clasts that come either from outside the cave or from the walls.

The total number of identified specimens of macrofauna from the Aurora stratum is 669, from an excavated area of 6 m², found together with 205 artifacts (Díez et al., 1999; Table 5.2). According to Díez et al. the NISP is 667, but we have corrected this value considering the NISP and MNI of carnivores identified by García and Arsuaga (1999) in excavation levels TD 38–43 corresponding to the Aurora stratum. Remains of six individuals of *Homo antecessor* are included in the macrofauna because the careful taphonomic analysis of Fernández-Jalvo et al. (1999) has shown that they had been cannibalized and used as food.

The minimum number of elements was provided in the publication, so it is possible to make a diagram with the skeletal completeness by regions and different size classes (Fig. 5.2). This diagram shows a good representation of limb bones, which suggests primary access to complete carcasses, supporting the indication of butchering provided by frequencies of cutmarks

preferentially located on diaphyses (cutmarks located on diaphyses are defleshing marks and are considered an indication of primary access to a fully-fleshed carcass, see Introduction), and by frequencies of percussion marks (Table 5.3). Carnivore tooth marks are slightly less frequent than cutmarks; they have a small diameter (less than 5 mm) so it is suggested that they are from canids; in three cases they overlapped cutmarks indicating that canids scavenged bones abandoned by humans. Very few skeletal elements are intact (some phalanges and short bones); bones have fairly high frequencies of curved and V-shaped fractures, of oblique fracture angles and of bone splinters with shaft diameter less than half the original diameter (Díez et al., 1999: figs. 4–5). These patterns of bone breakage are clearly indicative of bones broken when fresh to extract marrow (Villa and Mahieu, 1991).

Some observations suggest a relatively short period of time for assemblage formation: (a) the bone accumulation and the stone artifacts have the same vertically restricted distribution, and there is no evidence of sorting by size or water transport; (b) 19 refitting links of human and animal bones have been found; some go across the depth of the level, supporting the idea of a short interval of time for deposition (Díez et al., 1999; Fernández-Jalvo et al., 1999: fig. 11).

Juveniles and medium to small sized animals predominate in this assemblage. The six human individuals (Fig. 5.3) are two infants (3–4 years old), two adolescents (11 and 14 years old), and two young adults (16–18 years old); the large to small size ungulates (*Mammuthus* and rhino are excluded) include eight infants and juveniles, four adults, and only two old individuals (one equid and one *Megaloceros*; Díez et al., 1999: table 3). In well-preserved assemblages accumulated as a result of normal mortality over a period of years, juvenile

TABLE 5.2. Stone artifacts and faunal remains in early sites in Spain. The total NISP in TD 6 includes bones anatomically identified to body size but not to taxon. The carnivore NISP remains belong to *Ursus* (3), *Canis mosbachensis* (2), *Vulpes praeglacialis* (3), *Crocuta* (2), *Lynx* (1), *Mustela palerminea* (1) and Canidae indet (1) (From Díez et al., 1999; García and Arsuaga, 1999; Fernández-Jalvo et al., 1999; Palmquist et al., 2005; Santonja and Villa, 2006).

Site	Stone artifacts	Taxon	NISP	MNE	MNI
Barranco León	295	<i>Equus</i> and many other species	>1,000	–	–
Fuentenueva 3	244	<i>Mammuthus meridionalis</i> , <i>Equus</i> , many other species	>1,400	–	–
Gran Dolina TD 6, Aurora stratum	205	<i>Mammuthus</i>	2	1	1
		<i>Stephanorhinus</i>	7	5	2
		<i>Bison</i>	55	35	2
		<i>Equus</i>	18	12	3
		<i>Megaloceros</i>	8	8	2
		<i>Cervus elaphus</i>	15	12	2
		Indet. large size cervids	94	34	1
		<i>Dama</i>	20	20	2
		<i>Capreolus</i>	5	5	2
		<i>Sus</i>	1	1	1
		<i>Homo</i>	92	69	6
		Possible <i>Homo</i>	90	30	–
		Carnivores	13	13	6
		Total	669		
Sima del Elefante	25	–	–	–	–

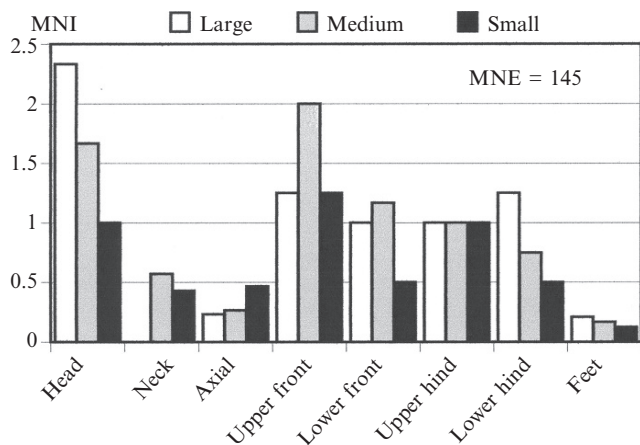


FIG. 5.2. Skeletal element abundance of faunal remains in TD 6 according to the anatomical regions defined by Stiner (1994). The total number of elements in any given region in a living animal (carnivores and Homo are excluded) is given in parenthesis. They are as follows: head (3) = 2 half-mandibles and 1 cranium; neck (7) = atlas, axis, cervical vertebrae 3–7; axial (49) = thoracic, lumbar, sacral vertebrae, 2 innominates and ribs; upper front (4) = scapula and humerus; lower front (6) = radius, ulna, metacarpal; upper hind (2) = femur; lower hind (8) = tibia, calcaneum, astragalus, metatarsal; feet (24) = 1st, 2nd and 3rd phalanx. Teeth, carpals, metapodials, patellas and long bone shafts are not included in Stiner's regions. Her first region (antler and horncores) is omitted because there were very few specimens in the Aurora stratum; various shed antlers occur in TD 6 but below the Aurora stratum (Made, 1999). Size classes were established by Díez et al. as follows: large includes *Bison*, *Equus*, and *Megaloceros*; medium includes red deer and indeterminate cervids of similar size; small includes *Dama*, *Capreolus*, and *Sus*. Values for each region are obtained by dividing the MNE of each region by the total number of elements in each region. The remains of *Mammuthus* and *Stephanorhinus* were included in the large class by Díez et al. (1999) due to their very scarce representation; it was not possible to exclude them from this diagram because MNE were calculated by classes. No information was provided for sacrum so the total number of elements used in this diagram for the axial region is 48, instead of 49.

TABLE 5.3. Bone modifications on animal and human bones at TD 6. Totals include indeterminate bone fragments. Cutmarks on limb bones are preferentially located on diaphyses (41/46), a few on near-epiphyses (4/46) and none on epiphyses. Percussion marks are calculated on long bones. No marks were observed on proboscideans, rhinos and suids (mostly represented by teeth) (From Díez et al., 1999).

Type of marks	%	Total
Cutmarks	14.9	150/1,010
Percussion marks	12.7	42/330
Tooth marks	12.6	127/1,010

age groups are abundant relative to adults, reflecting the high mortality of young animals; beyond a certain age, very old individuals are also well-represented (Voorhies, 1969). Scavenging carcasses that died a natural death might seem a

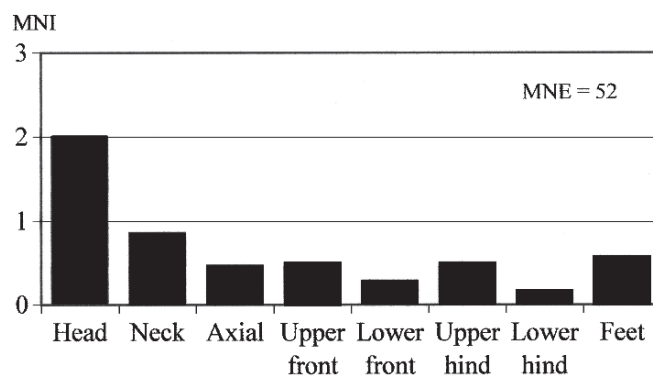


FIG. 5.3. Anatomical representation of human remains in TD 6. Regions as in Fig. 5.2 but the number of elements in each region is different from values of herbivores. The upper front region (scapula + humerus) includes clavicles. The total MNI is six and it was independently calculated taking into account the size, side and age of bones and teeth (From Fernández-Jalvo, 1999).

possibility. Yet assemblages accumulated by scavengers are unlikely to show a predominance of juveniles. The difficulty of locating small carcasses and the faster rates of biochemical deterioration due to low volume relative to surface area prevent scavengers from profiting of juvenile deaths, making carcasses from old animals more available to scavengers (Stiner, 1994: 300 and references therein).

Scavenging from abandoned carnivore kills can be excluded because carnivores rapidly consume young carcasses (Vrba, 1980). In fact, archaeological profiles in which young animals are common are often seen as reflecting active human hunting (Klein and Cruz-Urbe, 1991). The occurrence of cutmarks, percussion marks and bone breakage on both human and animal remains, and the prevalence of defleshing marks on limb diaphyses (Table 5.3) clearly indicate human butchery of fully fleshed bones. The frequencies of skeletal elements (Fig. 5.2) refute a hypothesis of passive scavenging which would require a head-dominated or head-and-foot dominated pattern, and an age profile with a bias toward old individuals, as was suggested by Stiner (1994) in the case of Moscerini. The predominance of juveniles and of small to medium size animals might indicate hunters taking advantage of more vulnerable prey (Klein, 1978), though this kind of generalization cannot be based on one case only.

Sites from the Early Part of the Middle Pleistocene

In Western Europe there are only four sites older than OIS 12 (older than 400 ka) for which we have useful taphonomic data: Isernia, Venosa Notarchirico (level alpha), Boxgrove, and Miesenheim I. Arago cannot be included because there is, as yet, no complete faunal and taphonomic analysis of any

single level, although we do have general papers (Moigne and Barsky, 1999; Lumley et al., 2004), paleontological papers, and doctoral theses on specific taxa (e.g. Monchot, 1996).

Isernia

Controversies about the age of Isernia (Villa, 1996) once dated by K-Ar to 730 ± 40 ka and by reversed polarity at or below the Matuyama-Bruhnes boundary (at the time the boundary was set at 730 ka but has since been redated at 788 ka; Klein, 1999: 51) have been settled by new $^{40}\text{Ar}/^{39}\text{Ar}$ dates on several sanidine crystals from tuff layers within the cross-bedded sands that cover level 3a, the main bone and artifact concentration at the site. The mean age is 606 ± 2 ka (Coltorti et al., 2005); this estimate matches the macrofaunal and the rodent faunas. *Arvicola terrestris cantiana* occurs at Isernia. This water vole with rootless molars, assumed to be a descendant of *Microtus savini* with rooted molars, appears in the second half or toward the end of the Cromerian Complex (for this climato-stratigraphic unit of the Middle Pleistocene see Klein, 1999: 28) i.e. between 0.6 and 0.5 Ma ago. The *Arvicola* from Isernia has been characterized as a primitive population, since a small proportion of the molars show evidence of root formation; a date of 0.6 Ma would be consistent with this observation. The presence of *Elephas (Palaeoloxodon) antiquus* and *Bison schoetensaki* also support a younger age for Isernia, again at approximately 0.6 Ma (see discussion in Villa, 2001 and references therein).

Layer 3a, excavated over a surface area of about 130 m², has yielded 334 artifacts of flint (average size is 2–4 cm) and limestone (some choppers and broken cobbles), and a spectacular concentration of macrofaunal remains (Peretto, 1994, 1996; Table 5.4) of mostly large-sized animals in a sandy matrix. The level has been interpreted by the excavators as an accumulation of essentially anthropic origin only partly displaced by a debris flow due to the volcanic eruption that provided the sanidine crystals.

The horizon contains many large blocks of travertine (Fig. 5.4), which may have acted as a barrier causing the grouping of materials already localized in ponds or abandoned channels. Bones are in variable states of preservation

TABLE 5.4. Isernia. List of larger mammals found in layer 3a. The total number of macrofaunal remains is 4,240, of which 980 are unidentified shaft fragments. A few fragmented teeth of probable *Hippopotamus*, *Sus scrofa*, *Hemitragus* and one tooth of *Panthera leo fossilis* are not included. Cervids include antler fragments, teeth and a few postcranial bones of *Maegaceroides solilhacus*, *Cervus elaphus*, *Dama dama* cf. *clactoniana* and *Capreolus* sp. Note that the *Megaloceros* is mostly represented by shed antlers (After Peretto, 1996).

Taxon	NISP	MNI
<i>Bison schoetensaki</i>	744	61
<i>Stephanorhinus hundsheimensis</i>	358	31
<i>Elephas (Palaeoloxodon) antiquus</i>	378	9
<i>Ursus cf. deningeri</i>	99	13
Cervids	46	–

and many are affected by postdepositional compression fractures. Microscopic analysis of a sample of 40 bones indicates the occurrence of weathering cracks, abrasion striations, and loss of cortical surfaces due to postdepositional erosion. SEM analysis of the surfaces (carried out by G. Giacobini, in Anconetani et al., 1996) showed that abrasion striations mimicking cutmarks are probably due to friction by the numerous phenocrysts of volcanic origin present in the sedimentary matrix. Possible cutmarks were identified on three bones, all attributed to *Bison schoetensaki*, but they could not be verified with confidence due to their bad state of preservation. Some photos document rounding of fracture edges (Anconetani et al., 1996) although there is no systematic reporting on degrees of abrasion. Some bone long axes show preferred orientation (Giusberti et al., 1991), and the abrasion striations seem to us consistent with materials having been displaced by the viscous mixture of water, sand, silt, and rock debris which buried the paleosurface.

Carnivore marks are said to be scarcely represented. Significantly, a number of bison long bones are reported to have percussion marks (67 of 572), and some of the published photos are convincing (Peretto, 1996: Figs. 6.11A, 6.13, 6.14, 6.16).

The excavators used a number of arguments to support the idea that the accumulation was the result of several episodes of hunting and butchering (Sala, 1996):

1. Anatomically connected units and complete bones are an important character of natural accumulations; at Isernia all bones are disarticulated and broken.
2. The material is not sorted, thus there is no evidence that the material was transported and concentrated by fluvial action like a flood.
3. The selectivity in skeletal representation, with a predominance of cranial parts from large size animals such as bison and rhinoceros (Fig. 5.5) is due to human action. The excavators thought that large bones were selected to consolidate a swampy area, unlikely as this may seem (Sala, 1996: 47).
4. The evidence of preferred orientation is limited and bones are horizontal, not jumbled up as might be expected in a volcanic mudflow.
5. There is no evidence of carnivore damage, except for small carnivores (Anconetani in Peretto, 1996: 128), so deaths are not due to carnivore predation.

As we will see, many of the features of the Isernia accumulation are not necessarily due to human action, throwing serious doubts on the interpretation of this occurrence as representing the remains of an ancient hunter/gatherer campsite.

There are at least two known cases of Miocene bone beds in Nebraska that show features identical or very similar to the bone concentration of Isernia. The Agate Fossil Beds National Monument is the locus of major mammalian bone beds preserved within fluvial sediments and near waterholes, containing the bones of hundreds of individuals of a small rhino (*Menoceras arikarensis*), of 50–70 large-sized chalicotheres (*Moropus elatus*, a perissodactyl with claws on the feet

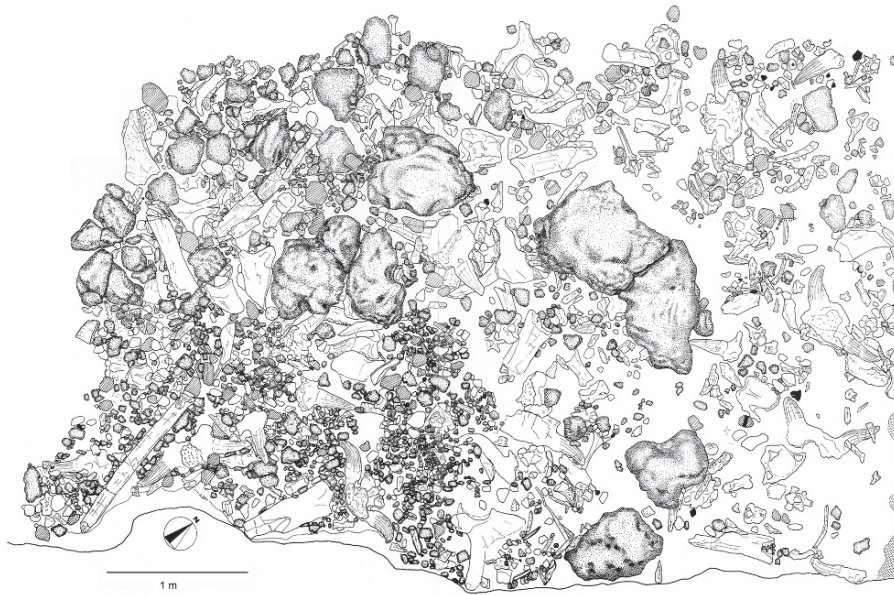


FIG. 5.4. Isernia. Plan of a portion of layer 3a. Note the large blocks of travertine forming a semicircle and many smaller natural cobbles, especially to the south of the distribution. Modified after Giusberti et al., 1983.

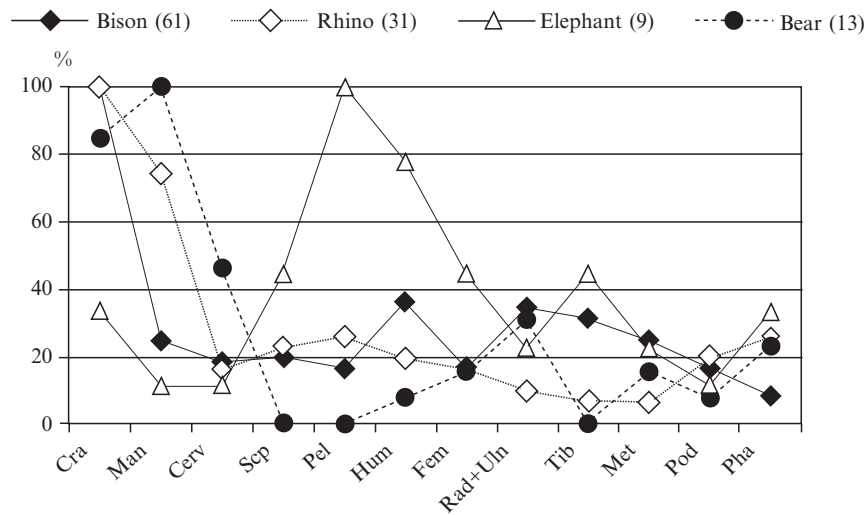


FIG. 5.5. Bodypart representation by percentage of MNI at Isernia, level 3a. Minimum number of individuals for each taxon in parenthesis (From Anconetani in Peretto, 1996).

rather than hooves, and weighing as much as 1,000 kg for adult males), a few bones of a very large primitive artiodactyl (the entelodont *Dinoyus hollandi* which was probably a scavenger), and extremely rarely, isolated and abraded bones of other mammalian species. These bone beds reflect natural deaths due to drought on river banks and in ponds; bones were displaced by river action. The density of bones is high comparable to Isernia, with as many as 100 bones per square meter, down to 40 bones at the periphery (Hunt, 1990).

The diagram in Fig. 5.6 compares the anatomical representation of the Isernia rhino (MNI = 31) with that of chalicotheres (MNI = 14) from one of the excavated localities in Agate Fossil Beds National Monument. The chalicotheres bones were disarticulated and formed a single bed; the bones were not aligned (like at Isernia), showed moderate degrees of abrasion, no evidence of sorting, and there were a good deal of green bone fractures. We have chosen the Isernia rhino because its MNI and live size correspond better to that of the

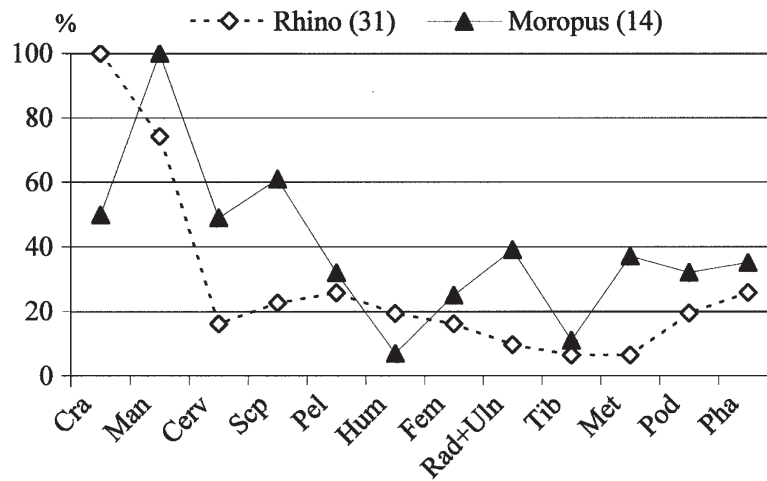


FIG. 5.6. Bodypart representation by percentage of MNI of the Isernia rhino in level 3a and of *Moropus elatus*, the chalicothere of the Agate Fossil Beds, Carnegie Quarry 2 (Miocene), Northwest Excavation. Minimum number of individuals for each taxon is given in parenthesis. The Northwest Excavation yielded dispersed and scattered bones at the periphery of a waterhole, a context comparable to that of Isernia (Data on *Moropus elatus* is from Hunt, 1990: Figure 22 top. Hunt's figure gives precise proportions of skeletal completeness for each of the bodyparts used in this diagram).

Agate chalicotheres; but a diagram with the bison would show the same pattern. It is clear that the predominance of cranial parts and many other features of the Isernia layer 3a are not necessarily due to human action since they also occur in the beds of Miocene age.

Likewise, the bone bed of Unit 3 in the Valentine quarry (Miocene, Nebraska), excavated over a surface of 1,300m², contained an unsorted concentration of bones of various mammalian species (mainly horses) in a low velocity stream, with boulders up to 50cm in diameter (like the travertine blocks of Isernia). A high percentage of bones was unweathered and had not undergone significant transport but disarticulation was complete; bones showed little evidence of preferred orientation and were lying horizontally, contained in a layer 5–80cm thick. The variable degrees of weathering and abrasion suggested that bones were derived from a range of sources, that many originated in the immediate vicinity, and that depositional processes were not uniform during formation of the layer (McCool, 1988). Similar observations have been noted at the Lower Pleistocene paleontological site of Untermassfeld in Germany (Kahlke, 1999), which has no evidence of human action.

The only valid argument that associates the artifacts with the bones at Isernia is the presence of percussion marks on some bison bones. We conclude that human exploitation of the bones certainly occurred, but there is not enough evidence that the faunal accumulation was exclusively due to human action and we cannot say if the fauna was hunted or scavenged.

Venosa Notarchirico, Miesenheim I, and Boxgrove

For the other three sites for which good taphonomic and faunal analysis data are available (Table 5.5) only Boxgrove

(the locus GPT 17 unit 4b, called “the horse butchery site”) provides rather good evidence in favor of hunting. The other two sites were formed by a combination of natural processes and anthropic activities, and cannot be used to prove either hunting or scavenging. Miesenheim probably accumulated over a long period of time but it is difficult to disentangle the different processes that shaped the site (Turner, 1999). At Venosa, bone remains also seem to have multiple origins although the human presence is stronger (Piperno, 1999; Tagliacozzo et al., 1999).

The case for hunting or aggressive scavenging at Boxgrove is strong. It is based on a number of facts: (a) all skeletal elements of a single horse are represented. As noted before, passive or non-confrontational scavenging of carcasses that died natural, non-violent deaths, or were left from kills of other predators does not allow scavengers to exploit as much of the carcass as they encounter (O'Connell et al., 1988; Stiner, 1991: 465); (b) the frequencies of cutmarks are high and they occur on most of the larger bones, proving that the carcass was fleshed when butchered; (c) the frequency of refitting between lithic artifacts and some bones, the restricted vertical distribution of the horse bones, and the very fresh appearance of the artifacts indicate that a single episode of butchery is represented. The spread of lithic artifacts and bones and the fact that six flint nodules were brought to the site, and knapped to produce flakes and at least one handaxe (based on a void in the middle of a refitted nodule) suggest that a group of people took part in the butchery process (Roberts and Parfitt, 1999).

We should briefly mention a younger site, the Acheulian site of Ambrona in Spain, with a minimum age of 350ka, possibly correlating with OIS 11 (Falgüeres et al., 2006). This is a deeply stratified site with faunal and lithic remains found in different sedimentary context. The most abundant species are

TABLE 5.5. Taphonomic and faunal data from sites in Western Europe dated between OIS 19 and 12. At Venosa Notarchirico level alpha is at the top of the sequence, so it is younger than 640 ± 70 ka, a TL date from a trachytic cinerite representing an ash fall of the Vulture volcano which occurs toward the base of the archeological sequence (Villa, 2001). The total excavation area at Miesenheim I is 436 m² but the main concentration of materials was about 300 m² (From Tagliacozzo et al., 1999; Turner, 1999; Roberts and Parfitt, 1999).

	Venosa Notarchirico, level alpha (20–30 cm thick)	Miesenheim I Upper part of layer G, and layer F (about 50 cm)	Boxgrove GTP 17, Unit 4b
Age	>OIS 12	ca. 600 ka	500 ka (OIS 13)
Excavated area (m ²)	62	About 300	150
Stone artifacts	950	100	>1,800 high frequencies of refitting
NISP	645	755	245
Main taxon	<i>Dama</i> (58% of NISP, 10 MNI) Also <i>Bos/Bison</i> , elephant, other cervids	13 species of larger vertebrates, cervids are most common, some articulated remains.	<i>Equus ferus</i> (other remains are inter- preted as background accumulation)
MNI	18	38	1, a single adult female
Cut marks	Not observable	No	46% (69 of 150)
Percussion marks	Some (two percussion marks and two bone flakes)	1	On humerus, radius, femur, mandible and indeterminate long bones
Gnaw marks	Two doubtful cases	Several	On five bones; on three pieces they overlap cutmarks
Carnivores in the assemblage	No	15.7%	No
Abrasion on bones	Present on all bones from slightly (45%) to abraded (20%) to very abraded (35%)	No	No
Abrasion on stone artifacts	6–40% are slightly abraded to abraded, depending on raw material (flint, limestone)	No	No
Origin of the assemblage	Mixed human and natural processes	Mostly natural, some human presence	Human

elephant (*Palaeoloxodon antiquus*), cervids (*Cervus elaphus*, *Dama*), bovids (*Bos primigenius*), and equid (*Equus caballus torralbae*). The taphonomy of the Lower Complex from the central area of the site, with impressive finds of elephant bones and Acheulian bifaces and cleavers, has been extensively published (Villa et al., 2005a) and we briefly summarize it here. The analysis shows that the site is a complex mix of natural and human components and that some of the faunal remains of elephants and cervids represent natural occurrences without any clear evidence of hominid intervention. Evidence of human action on bones is provided by a few SEM verified cutmarks and anthropic bone fractures, documenting butchery of various animals, including elephants. A definitive interpretation of this controversial site (Freeman, 1975, 1978; Binford, 1987; Freeman, 1994) is limited by postdepositional disturbance processes, the loss of observable cortical surfaces on bones, and the fact that some materials probably derive from nearby locations now destroyed by erosion. However, the skeletal element representation and the lack or scarcity of carnivore modifications allow us to definitely reject Binford's idea of marginal scavenging of medium-size ungulates from carnivore kills. The site was regularly visited by hominids who transported some artifacts from non-local raw material sources and had an organized approach to meat acquisition. Whether meat was acquired through hunting or by taking advantage of natural deaths, we cannot say. It is only at late Middle Pleistocene sites like La Cotte de St. Brelade and the Late Pleistocene site of Lehringen that hunting of elephants (and rhinos) can be put forward as a valid hypothesis.

Late Middle and Late Pleistocene Sites

Hunting of large game is documented by a number of European sites dated to the second half of the Middle Pleistocene and the first part of the Late Pleistocene, beginning with well-known site of Schöningen in Germany (Thieme, 1997, 2000). Table 5.6 provides a list of sites later than Schöningen and dated between OIS 6 and 3, where the strongest evidence for hunting is provided by the topographic setting and the kind of accumulation. These sites show the use of cliff faces and rocky barriers associated with karstic systems for stampedes of one or two species of large mammals.

At La Cotte de Saint-Brelade (Jersey, English Channel Islands), layers 3 and 6, dated to OIS 6 by TL dates and stratigraphic data, are two separate accumulations of bones of woolly mammoths (total MNI = 18) and woolly rhinoceros (total MNI = 5). Only a small portion of the original site was excavated, approximately 12 m² in layer 3 and 18 m² in layer 6. Mammoths and rhinos comprise essentially the entire fauna of these two levels; a few bones of other species occur only at the base of each level. The site is at the base of a deep ravine (about 30 m at the time of deposition of layers 3 and 6), and there are several indications that these were rapid accumulations: some bones were found to rest vertically against other bones, a few bones were found in articulation, several mammoth scapulas were stacked in direct contact with each other without intervening sediment, and there was no evidence of subaerial weathering. The age distribution indicates a predominance of sub-adults and prime-age adults. It would have been impossible

TABLE 5.6. After Scott, 1986; Jaubert et al., 1990; Farizy et al., 1994. Gaudzinski, 1996b Jaubert et al., 2005; Brugal and Jaubert, 2006; also provides data on the bovid assemblages from Il'skaja (Russia) and Wallertheim (Germany) but we have not included them in this table as they have a more varied fauna with different accumulation histories.

Site	Age	Main fauna	MNI	Topographic setting	Evidence of hunting
La Cotte St. Brelade layers 3 and 6	OIS 6	<i>Mammuthus primigenius</i> , <i>Coelodonta antiquitatis</i>	7, 11 2, 3	Base of deep ravine	Rapid accumulation of only two very large species, almost no other species present
Coudoulous 1 layer 4	OIS 6 ca. 160ka	<i>Bison priscus</i>	232	Karstic depression, open sky	Monospecific accumulation
La Borde single layer	OIS 7 or 5	<i>Bos primigenius</i>	40	Karstic depression, open sky	Monospecific accumulation
Mauran	OIS 3	<i>Bison priscus</i>	137	Base of an escarpment with rocky barrier	Monospecific accumulation

to kill a group of such dangerous animals without driving them off the cliff. Rhinos are frequently found on the fringes of herds of elephants, so they could have been driven together with the mammoths (Scott, 1986).

Like La Cotte, none of the other sites in Table 5.6 are really a cave or rock shelter in a strict sense. They are practically open-air sites in the sense that they were not protected by an overhanging roof; they were, however, physically constrained. La Borde and Coudoulous are accumulations in karstic depressions. At the time of accumulation Coudoulous had an open sky but was limited by a rocky wall on three sides. The archeological layer at La Borde was limited on two sides by a rock face. Mauran is at the base of an escarpment separated from the Garonne river by a rocky barrier. The three sites in SW France appear to have formed by a number of different episodes now occurring in the form of palimpsests (Jaubert et al., 1990; Farizy et al., 1994; Gaudzinski, 1996b; Joubert et al., 2005). Significantly, layers 3 and 6 at la Cotte preserve stratigraphic evidence strong enough to indicate two discrete episodes of mass killing.

Data from many other Middle Paleolithic sites show that Neanderthals hunted a wide range of prey, from dangerous animals such as brown bears, mammoths, and rhinos (Auguste, 1995; Bratlund, 1999) to large, medium, and small-size ungulates such as bison, aurochs, horses, red deer, reindeer, roe deer, and wild goats (Jaubert et al., 1990; Chase, 1999; Hoffecker, 1999; Hoffecker and Cleghorn, 2000; Conard and Prindiville, 2000; Roebroeks, 2001; Fernández and Legendre, 2003; Bar-Oz et al., 2004). Evidence of cutmarks on beaver bones suggest processing for pelts at Grotta Maggiore di San Bernardino in Northern Italy (Fiore et al., 2004). Cutmarks occur on ungual phalanges of the golden eagle (*Aquila chrysaetos*) in Mousterian levels at Pech de l'Azé I and Grotte de l'Hyène in France, and at Grotta di Fumane in Northern Italy (Fiore et al., 2004), suggesting removal of the claw for use as an ornament. Cutmarks on a swan phalanx have also been reported from a French Mousterian cave (Laroulandie, 2004). Aside from these few instances, however, hunting of birds for meat consumption remains uncertain; several sites in Spain, Italy, and France have yielded remains of aquatic and galliform birds, but we lack confirmation from taphonomic analyses (Villa and d'Errico, 2001; Fiore et al., 2004). Evidence for rabbit hunting is provided again by cutmarks, fresh bone breakage,

and damage by disarticulation by flexion at just a few sites, e.g. Grotte de la Crouzade and Les Canalettes in Southern France (Cochard, 2004; Costamagno and Laroulandie, 2004).

Shellfish gathering is reported from some coastal caves in Italy and the Iberian peninsula, but the absolute quantities are small, not comparable with the shell middens of Mesolithic sites in Italy, coastal Spain, and Denmark (Stiner, 1993, 1994: 194; Kuhn, 1995: 177). Among the Mousterian sites in coastal Latium only Moscerini shows significant numbers of marine mollusks, but even there they are not especially abundant. The MNI of shell fish for the whole sequence at Moscerini (spanning the later part of OIS 5 and OIS 4 approximately 100–66ka) is 613 (Stiner et al., 1999, table 1)² including mostly sand clams (*Callista chione* and *Glycimeris*), mussels (*Mytilus*) and a smaller number of other bivalves (*Cardium edulis*) and gastropods (*Patella*, *Monodonta turbinata*; Stiner, 1994). At Vanguard, the MNI of shellfish (mostly mussels) associated with a hearth dated between 49 and 45 ka is 73 (Barton, 2000). At Gruta da Figueira Brava (Raposo, 2000; Zilhao, 2001) significant numbers of *Patella* are reported from level 2, dated to about 30ka; the site is close to a beach, like Moscerini and Vanguard caves. Other coastal Mousterian sites in the Iberian peninsula are reported to have mollusks (e.g. Gorham's Cave, Bajondillo Cave, sites on the Bay of Malaga; Barton, 2000; Cortés Sanchez, 2000), but detailed data are not yet available.

Mollusks can be overrated as a source of food. It is estimated that approximately 31,000 limpets (*Patella vulgata*) or 156,000 cockles (*Cardium edulis*) are required to supply the calorific equivalent of a single red deer carcass; 700 oysters or 400 limpets are needed to supply enough calories for one person

²The MNI of shellfish at Moscerini is based on percentage counts (93% of 660 total of small game and shellfish) provided in Table 5.1 of Stiner et al., 1999. We found difficult to calculate total shellfish MNI from numbers published in Stiner, 1994 (Tables 6.12–6.15) which provide NISP and hinge counts by individual layers. She recommends dividing hinge counts by two for bivalves to avoid the problem of fragmentation and this gives a MNI of 285 for bivalves such as *Callista chione*, *Cardium*, *Mytilus*, and *Glycimeris*. However Stiner's tables for gastropods (e.g. *Patella*, *Monodonta turbinata*) also contain hinge counts, which is confusing since gastropods do not have a hinge. The hinge is the structure at which the two valves are joined in a bivalve.

for 1 day if no other food is eaten (Bailey, 1978). At Mesolithic sites such as Meilgaard (Denmark), which was occupied for a few hundred years by a semi-sedentary community, 50m³ of deposits (representing only a small portion of the whole site) contained a minimum number of 100,000 oysters (Bailey, 1978). By comparison, the shellfish remains from Mousterian sites represent very small quantities. The limited evidence available for fishing in the Middle Paleolithic, including sparse remains of fish and marine mammals from Figueira Brava, also do not suggest an economically significant resource (Le Gall, 2000). Intensive use of marine food is documented only from the Late Upper Paleolithic onwards (Richards et al., 2005).

Use of shellfish as a raw material for scrapers has been reported for a number of Middle Paleolithic sites, in particular Moscerini, where Vitagliano (1984) described a fairly large number (about 100) of transverse and déjété scrapers on valves of *Callista chione* (sand clam). Other Middle Paleolithic coastal sites in Northern and Southern Italy also are reported to have tools on *Callista chione* (Vitagliano, 1984: fig. 2). This particular use of shells is not limited to Italian Neandertals. Three backed pieces made on limpets occur in the Howiesons Poort layer 11 of Klasies River Mouth (Singer and Wymer, 1982: Figs. 6.3.28–6.3.30 and P. V. personal observation, 2006). The Howiesons Poort at Klasies is dated to about 66 ± 5 ka or possibly between 55 and 60 ka (Soriano et al., 2007) so the occurrence might be just slightly younger than Moscerini, where ESR dates put the sequence roughly between 115 and 65 ka (Stiner, 1994: 35).

Remains of land tortoises (*Testudo graeca*) and aquatic turtles (*Emys orbicularis*) are reported by Stiner (1993, 1994) in unit M6 at Moscerini (NISP 39; MNI 5), with indications of human use such as impact damage and fresh break edges. At Gruta da Oliveira (Portugal), a late Mousterian site with levels dated to between 32 and 38–40 ka, tortoise remains are said to be common, and one scapula was cut-marked; at Gruta Nova da Columbeira (also in Portugal) levels with an estimated age of 54–61 ka have yielded 338 NISP of *Testudo hermanni* (another land tortoise) together with a large number (1,832) of Mousterian stone artifacts (Zilhao, 2001).

Undoubtedly, bovids, equids, and cervids are the most common prey species at Middle Paleolithic sites. Nevertheless the evidence of shellfish and small game hunting/gathering shows that Neanderthals were exploiting the same variety of resources as Upper Paleolithic humans (Zilhao, 2006). Sites such as La Cotte, Coudoulous, Mauran, and La Borde strongly suggest that hunting could be logistically organized as in the communal game drives and kill sites of late Upper Paleolithic and Paleoindian times.

Middle Paleolithic Hunting Weapons in Western Europe

If Neanderthals were capable of killing large game and prime-age animals, and hunting was their regular method of meat procurement, the next question to ask is: what kind of weapons did

Neanderthals use to dispatch their prey? Did they use stone-tipped spears? This question is especially appropriate for the Western European record which has, until now, provided good evidence only for the use of wooden spears at the sites of Schöningen and Lehringen in Germany (Thieme and Veil, 1985; Veil and Plisson, 1990; Thieme, 1997, 2000). The six Schöningen wooden spears, dated to about 400–300 ka and associated with remains of at least 19 horses (*Equus mosbachensis*) have a diameter of 29–50 mm and a length of 1.8–2.5 m. Most of the spears were made from individual spruce trees, one was made from pine. The trees were felled, the bark, lateral twigs, and branches removed; the tips are worked from the hardest part of the wood at the base of the tree. The spears have been interpreted as javelins because their maximum thickness and weight is situated a third of the way from the tip, like in modern javelins. The Lehringen spear, also from Germany, made of yew wood and dated to OIS 5e, was found among the ribs of an elephant; its weight is concentrated on the proximal end, thus its use as a thrusting spear is a reasonable inference. The spear was 2.39 m long; its diameter was 3.1 cm at the base and 2.0 cm near the tip. The use of the Clacton “spear point,” also made of yew, is less certain since it was recovered outside an archaeological context (Oakley et al., 1977).

Spear Points in South Africa and the Near East

In South Africa and in the Near East, several scholars have concentrated their attention on lithic points of the Middle Stone Age (MSA) and the Middle Paleolithic (MP) and their functional interpretation. Residue, microwear and impact scar analyses of a sample of 50 MSA (post-Howiesons Poort) unifacial points from several layers at the rock shelter of Sibudu in South Africa by Lombard (2005a) have shown that these artifacts were hafted and used as tips of hand-delivered spears. Technological and morphometric analyses of 138 points and distal tips from layer RSP of the same site (dated to ca. 50 ka by OSL) by Villa et al. (2005b) supported this interpretation.

In the analysis of the RSP points, we examined a number of variables used by different authors who have studied prehistoric weapons technology, i.e. the tip cross-sectional area (TCSA, obtained by the formula: 1/2 maximum width × maximum thickness, expressed in cm² or mm²; Hughes, 1998), the penetrating angle, the maximum width (which is at least in part related to the width of the shaft), as well as the frequency of basal thinning (which is a way of accommodating the bases of the points to hafting procedures). Comparisons with archeological (North American and European Upper Paleolithic) and ethnographic data for the first three variables indicated to us that the Sibudu points were the tips of either thrusting or throwing spears. Shea (1988, 1998, 2003) had previously made the same suggestion for Levallois points from Levantine Mousterian sites, based on TCSA values similar to that of Sibudu RSP.

More recently Shea (2006) has conducted extensive statistical analyses of many Levallois and retouched unifacial and bifacial points from the Middle Paleolithic in the Levant. and from the Stillbay and post-Howiesons Poort phases of the South African

MSA, comparing the tip cross-sectional area of these MSA/MP artifacts with well-documented archeological and ethnographical examples of North American dart tips and arrowheads. The TCSA has been considered the best means to distinguish armatures of different weapon systems, whether arrows, spear-thrower darts, throwing, or thrusting spears (Hughes, 1998; Shea et al., 2002). Shea's statistical analyses strongly indicate that the Levant MP and the South African MSA points were used to tip hand-cast spears. His research is supported by the discovery of hafting traces (bitumen residues) on the proximal part of artifacts and of a Levallois point embedded in a wild ass cervical vertebra from the site of Umm el Tlel in Syria, dated to about 60ka (Boëda et al., 1996, 1999).

Spear Points in Europe

The situation is different in Western Europe where most work has been concentrated on the study of Upper Paleolithic points and studies of Middle Paleolithic points have lagged behind. The strongest argument for the existence of spear points has been advanced by Callow (1986) for a few Mousterian points from the site of La Cotte de Saint-Brelade in the Channel Islands. Out of nine Mousterian points in layer 5, dated to OIS 6, four exhibit burin-like or flute impact scars; two others had been repaired after breaking and are less sure (Fig. 5.7). Still, the scarcity of detailed studies of pointed forms in Western Europe is striking; the study of possible spear points in the Middle Paleolithic record of Western Europe is a neglected topic, in clear contrast to research trends in the Near East and South Africa.

Three factors probably account for this lack of attention:

- The influence of Bordes' typology which gives great importance to scrapers and tends to lower the significance of pointed forms by merging them into the convergent scraper category. Thus pointed forms are thought to be rare in the European MP, which appears dominated by scrapers.
- Research by H. Dibble (1987a, b, 1988, 1995) on the effects of intensive reduction of tools and the idea that convergent scrapers are a reduced form of double scrapers.
- A few microwear analyses showing that convergent scrapers had been mainly used to work wood (Beyries, 1988a, b; Anderson-Gerfaud, 1990).

These issues are discussed in greater detail in Villa and Lenoir (2006). We note, however, that the impression of low frequency of points in Mousterian assemblages is at least in part due to different ways of counting artifacts. High frequencies of pointed forms do occur in some Mousterian assemblages, such as Biache, Vaufray layer VIII, and Bérigoule in France, and Castelcivita in Italy (Villa et al., 2005b: Table 6; on Bérigoule see Richter et al., 2007). We expect that more cases will be recognized if we attract the attention of analysts to the subject.

Our analysis addresses this issue by providing information on points from Bouheben, a Middle Paleolithic/Final Acheulian site in SW France, and using comparisons with Middle Stone Age points from Sibudu and Rose Cottage; both of which contain long stratigraphic sequences with assemblages dated between 60 and 35 ka by OSL (Figs. 5.8–5.9). As indicated above, the Sibudu unifacial points have been previously identified as spear points (Lombard, 2005a; Villa et al., 2005b). The Howiesons Poort and post-Howiesons Poort lithic assemblages

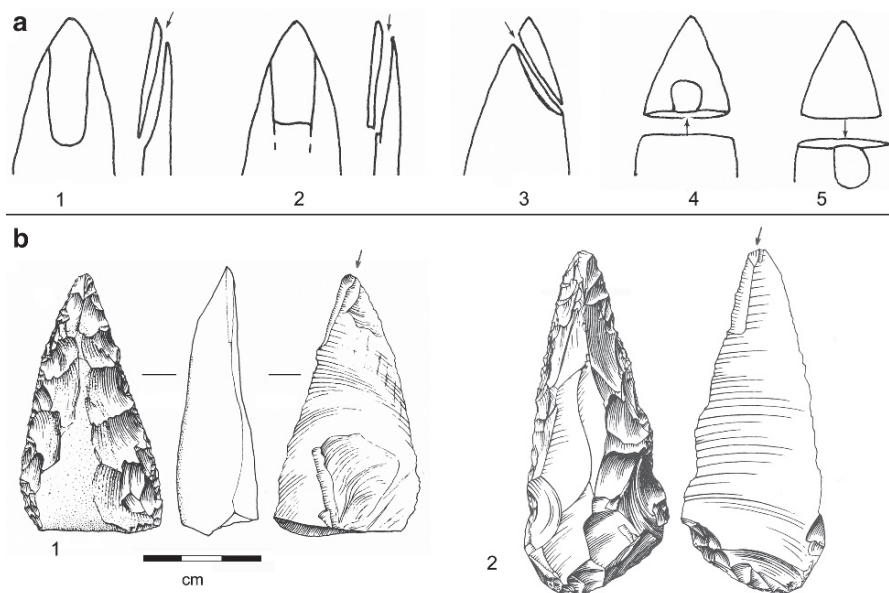


FIG. 5.7. (a) Schematic representation of impact scars on bifacial spear points from the Casper site (Wyoming, USA) a Paleoindian bison kill site, approximately 10,000 years old. 1 flute-like scar (i.e. bending fracture scar with feather termination in Fischer et al. terminology); 2 scar with step termination; 3 burin-like scar; 4–5 spin-off scars (Modified after Frison, 1974). (b) 1–2 Mousterian points from layer 5 at La Cotte de St. Brelade (Jersey, Channel Islands) with burin-like impact scars and thinned base (Modified after Callow, 1986).



FIG. 5.8. Map showing the location of the two Middle Stone Age sites mentioned in the text.

of Rose Cottage are the subject of another paper with more detailed information (Soriano et al., 2007).

The reason for selecting Bouheben, among so many other Middle Paleolithic assemblages, are simple: the assemblage was available for study, was well-excavated and has a high frequency of pointed forms (32% of formal tools in layer 2) comparable to those at Sibudu where layer RSP has 32.8% of unifacial points.

Bouheben (SW France)

Bouheben is an open air site in the department of Landes in the Aquitaine basin, located on a low plateau at about 117 m asl. Excavations were conducted by the late Claude Thibault in 1964 and in 1967–1969 on a surface of 43 m². According to Thibault (1970, 1976) the site was originally very large but was partly destroyed by a farm building, pathways, and digging of ponds. Bone was not preserved.

The upper part of the stratigraphic sequence contained two Mousterian levels (layer 1 and 1¹) and a Final Acheulian/Mousterian level (layer 2). The top of layer 1 was marked by a recent soil and the upper part of layer 2 was also marked by a weathering horizon, interpreted as Riss-Würm (Last Interglacial, i.e. OIS 5e) soil. A pollen diagram for the base of layer 2 indicated a dry, cold climate. There are no absolute dates to confirm the original assignment to the end of Riss (i.e. OIS 6). The lithic assemblage provides some clues to the site age.

The excavated assemblage of layer 2 is large: the total number of artifacts from layer 2 was more than 4,500; the total number of flake tools is 312, and there is a small number of bifaces (n = 12). The occurrence of bifaces supports a typological attribution to the Upper or Final Acheulian. Assemblages with Acheulian bifaces persist in the region until the end of the Middle Pleistocene, as indicated by the site of

Barbas I in the Dordogne region (Boëda et al., 2004) and by layer A at La Cotte de St. Brelade (Callow and Cornford, 1986). At Barbas layer C¹3, dated to 147 ± 28 and 146 ± 29 ka by two TL dates, contained 167 bifaces, more than 40,000 flakes and fragments resulting from the making of bifaces, and about 2,000 flake tools. Layer A at La Cotte, dated to OIS 6, is also characterized by small flint bifaces (n = 70) larger quartzite and dolerite bifaces and cleavers (n = 20) and large numbers of small flake tools of Middle Paleolithic character (about 2,516 of flint and 137 of quartzite and dolerite). Barbas I and La Cotte show that assemblages without bifaces, which appear in Western Europe during OIS 8 and OIS 7, continued to coexist until the end of the Middle Pleistocene with assemblages with rare bifaces and a repertoire of flake types in many respects indistinguishable from Mousterian industries of Late Pleistocene age (Santonja and Villa, 2006).

Four of the 12 Bouheben bifaces from layer 2 are from large quartzite cobbles and resemble the typical Acheulian bifaces from the Garonne and Tarn terraces, also made on quartzite cobbles. A second set of six bifaces consists of much smaller bifaces with length from 5 to 7 cm. These flint bifaces are unlike the cordiform bifaces of the Mousterian of Acheulian Tradition which in SW France is dated to OIS 3, between 65 and 40 ka (Soressi, 2002).

In conclusion, the estimated age of Bouheben layer 2 as dating to the end of the Middle Pleistocene, although unconfirmed by quantitative dates, is strongly supported by its quartzite bifaces, typical of the regional Acheulian. The total number of pointed forms from layer 2 is 100.

Layer 1¹ contained a smaller assemblage of about 2,200 artifacts, very similar to layer 2 in terms of debitage and retouched pieces (mainly scrapers). In both levels the Levallois debitage is present but not predominant, and there are a few blades made by direct percussion by hard hammer. A comparison of this assemblage to that of layer 2 in terms of percentage frequencies of Bordes' types shows that the two assemblages are practically identical (cf. the two cumulative frequency curves in Thibault, 1970: fig. 98). We have included in our sample, mostly derived from layer 2, the 25 pointed forms from the overlying layer 1¹ because they are similar to points from layer 2 in terms of dimensions, frequencies of bulbar thinning, and impact scars. Thus the total sample is 125 pointed forms, including 11 broken tips or distal fragments.

Most artifacts from Bouheben are made of Senonian flint which outcrops at about 6 km from the site. Almost all artifacts have a white patina and some are slightly desilicified; thus the level of identification of microwear traces is very low and residue analysis is excluded. However morphometric studies and studies of impact scars are possible; they are some of the main methods for identifying use as spear tips.

We have analyzed all Mousterian points and elongated Mousterian points; other pointed forms such as convergent scrapers and *déjeté* (i.e. canted) scrapers, so classed following Bordes' typology (Bordes, 1961), have been included in the database, unless they had a round or blunt distal end or were

too asymmetrical (see below observations on tip design). In Bordes' typology, distinctions between convergent scrapers and Mousterian points are based on the acuteness of the point, its thickness in profile, and bilateral symmetry. Thus, we followed traditional classificatory procedures for preliminary sorting, prior to detailed analysis of attributes expressing tool design (e.g. blank type, bulbar or lateral thinning, and kind of retouch) and morphometric features. We should make clear that our interpretations are not based on Bordes' typology but on morphometric and impact fracture analyses. Convergent and *déjeté* scrapers are excluded from all statistics, except in Table 5.8 for reasons explained in the caption. There are no unretouched Levallois points at Bouheben.

Sibudu (KwaZulu-Natal, South Africa)

This large rock shelter, approximately 40 km north of Durban and 15 km inland from the Indian Ocean, is under current excavation by Lyn Wadley. The stratigraphic sequence spans four MSA phases: the pre-Still Bay, the Still Bay, the Howiesons Poort and the Post-Howiesons Poort. Unifacial and bifacial points come from the post-Howiesons Poort layers, dated by OSL to ca. 60–36 ka. The excavated area (until 2005) varies from 2 m² for the lower part of the sequence to 18 m² for layer RSP and up to 6 m² for the top part of the sequence (Wadley, 2005; Wadley and Jacobs, 2006). Detailed analysis of the RSP lithic assemblage, one of the most extensively excavated post-Howiesons Poort layers at Sibudu, has been published by Villa et al. (2005b).

The analyzed sample consists of 272 specimens, which we have grouped in three subsamples: Final MSA layers from the East section (layers Ore to Co, dated by OSL between 50 and 36 ka), layers MOD-RSP (dated to ca. 50 ka), and layers below RSP from the North section (dated to ca. 60–50 ka; OSL dates and stratigraphy from Wadley, 2005; Wadley and Jacobs, 2006). All points from the first two subsamples have been analyzed. Points from layers below RSP represent artifacts that were found in preliminary sorting; thus the latter group may be incomplete (e.g. missing broken tips). For this reason the sample, which is quite large (70 pieces) is treated separately. There are, in addition, 41 pieces that would be classed as convergent scrapers in Bordes' typology. They are not included in the statistics unless specified. Our sample includes 36 bifacial points and 12 partly bifacial points; the rest are unifacial points. In the post-Howiesons Poort sequence, the two most common raw materials are hornfels and dolerite; the fine-grained hornfels is the preferred raw material for points (75.5%).

Rose Cottage (Free State, South Africa)

This large cave is located in the eastern Free State at 1,676 m elevation. It contains a long stratigraphic sequence with final MSA and Later Stone Age deposits (Wadley, 1997). The older MSA levels were excavated between 1989 and 1991 by Philip

Harper under the guidance of Lyn Wadley (Harper, 1997). Our sample consists of all the points from the post-Howiesons Poort levels and comes from the 6 m² in the center of the cave plan. OSL dates place these levels between 57 and 33 ka; TL dates on burned lithics are broadly comparable though slightly younger (Valladas et al., 2005).

In the Post-Howiesons Poort levels there are 44 unifacial points, six tips of unifacial points, two bifacial and four partly bifacial points. The Howiesons Poort levels contained only one unifacial point from a layer in the middle of the sequence; it is included in our sample which thus totals 57 pieces. There are no convergent scrapers. The main raw material is opaline (equivalent terms are chalcedony and opal), a siliceous rock that formed as lenses 5–15 cm thick, or as roundish nodules, similar to geodes, within the Drakensberg basalt (Early Jurassic) to the east. Opaline nodules from the eroded outcrops were carried by tributaries to the Caledon river, which runs 8–10 km from the site. Opaline is a fine-grained raw material of variable colours; the knapping quality is generally very high and comparable to flint. Most blanks are water-rolled quadrangular blocks or slabs of small dimensions, generally less than 6 cm in size (Soriano et al., 2007).

Morphometric and Impact Scar Analyses

Analyses of stone points from Paleoindian kill sites have shown that the attributes necessary for the proper functioning of a device to kill a large animal are a sharp point to penetrate the hide and sharp side edges to open a hole for the remainder of the point and shaft (Frison, 1978: 337–338). Tip design is critical for the penetration of a low velocity weapon (Hughes, 1998). Thus, analysis of lithic points to test the hypothesis that the points were used as parts of hunting weapons, must show three things:

- There must be some evidence of hafting.
- The points must have a sharp tip, to penetrate the hide.
- Some should have impact scars, proving their use as killing weapons.

In this paper the term “projectile technology” is used exclusively in reference to high velocity weapons delivered by spearthrowers or by bows, as in Shea, 2006. This distinction is necessary since in the published literature the term “projectile point” has been used not only in reference to high-velocity weapons, but also for any point used for killing whether tipping thrusting spears, spears thrown by hand (i.e. javelins), spears thrown with a spearthrower, or arrowheads. This is a cause of some confusion. Following terminology common in North American literature (e.g. Frison, 1974; Thomas, 1978; Hughes, 1998) we use the term “dart” to indicate spears thrown with a spearthrower (spearthrowers are also called atlatl) and reserve the term spears and spear points to hand-delivered low velocity weapons. Of course, it is not always possible to identify stone points as part of one or another weapon system or to distinguish between stone points used to tip thrusting or throwing spears.

Hafting

Strong evidence of hafting has been found on some of the Sibudu unifacial points by microwear and residue analysis (Lombard, 2005a). Residue analyses cannot be carried out on the Rose Cottage and Bouheben materials. However, bulbar thinning is a good proxy. Thinning of the base by removal of the original striking platform and flaking of the ventral surface is generally considered a way to accommodate the bases of the points to hafting procedures, making sure that the haft bindings or adhesives do not project much above the stone, thus decreasing haft drag. Table 5.7 shows that all three sites have similar proportions of thinned bases.

Sharp Tip

The TCSA (tip cross-sectional area, obtained by the formula: $1/2$ maximum width \times maximum thickness) is one of the variables that influence penetration of a low velocity weapon, hence its killing power: the smaller the TCSA the better the penetration. Shea (2006) provides descriptive statistics for ethnographic and recent archeological (North American) hafted stone points (spear points, dart tips and arrowheads) based on data provided by Thomas (1978), Shott (1997), and Hughes (1998) (see also Shea, 2008; Churchill and Rhodes, 2008). Table 5.8 shows that the Sibudu and Bouheben TCSA

TABLE 5.7. Basal thinning on points from Bouheben, Sibudu and Rose Cottage. Counts exclude convergent scrapers, bifacial points (frequent at Sibudu but very rare or absent at the other two sites) and pieces with broken or damaged base. In the great majority of cases basal thinning is done by inverse retouch removing the bulb of percussion. Counts differ slightly from a similar table published in Villa and Lenoir, 2006 because here we also exclude bifacial pieces.

Site	Basal thinning (%)
Bouheben ($n = 93$)	25.8
Sibudu ($n = 99$)	25.3
Rose Cottage ($n = 48$)	18.8

TABLE 5.8. Tip cross-sectional area data in square millimeter for Bouheben, Sibudu, Rose Cottage. Data for ethnographic and recent archaeological hafted stone points (spear tips, dart tips and arrowheads) is from Shea (2006) and is based on ethnographic and North American archeological materials (Thomas, 1978; Shott, 1997; Hughes, 1998). For Bouheben three calculated means are given: Bouheben MP for Mousterian points only, Bouheben CS for convergent scrapers and forms intergrading between the two types, and Bouheben All Pointed Forms, which exclude convergent scrapers. The TCSA of convergent scrapers is given for Bouheben because the distinctiveness of convergent scrapers and Mousterian points has been questioned. Note that the TCSA of convergent scrapers at Bouheben exceeds those of ethnographic and historic spear tips and should be excluded from consideration.

Sites	Mean	SD	Min	Max	n
Bouheben (MP only)	165	67.2	50	322	70
Bouheben (CS)	232	94.4	70	420	31
Bouheben (All Pointed Forms except CS)	177	73	50	375	98
Sibudu, final MSA (East section, layers Ore to Co)	116.2	41.5	45	200	21
Sibudu, layers RSP–MOD (North section)	117.7	57.6	19.5	294	71
Sibudu, layers below RSP (North section)	139.4	60	54	320	42
Rose Cottage	78	33	19.5	192	47
Arrowheads	33	20	8	146	118
Dart tips	58	18	20	94	40
Spear tips	168	89	50	392	28

mean values fall well within the range of throwing or thrusting spear. The Rose Cottage points instead have a smaller mean TCSA value (78) that may at first seem relatively close to the mean of dart tips (58). However a t -test shows that those values are significantly different ($t = 18.9$, $p < 0.001$). The reason for this clearly depends on the fact that the TCSA maximum value of the Rose Cottage points is much greater than those of dart tips (192 versus 94 mm²), and that the Rose Cottage points are thicker than darts (mean is 7.1 ± 2.2 versus 5 ± 0.9 mm).

Table 5.9 shows that the Rose Cottage points are the smallest of the three sites. The small size of the original unworked raw material is very likely the reason for their small size. There was no deliberate reduction in size, just the opposite: the mean length of flakes (flakes < 20 mm are excluded) is 25.1 ± 5.8 mm; the mean length of retouched pieces, exclusive of points, is 31.2 ± 10.9 ; the mean length of points 36.6 ± 8.7 . In other words, the Rose Cottage people consistently chose the largest available flakes for their points.

The statistics of the penetrating angle (the tip angle seen in plan view and measured in degrees) of all three sites are given in Table 5.10. This angle is related to the acuity of the point and its resistance to breakage (Peterkin, 1997). It was measured using the caliper method based on measurements of width at 1 cm from the tip; the angle is then calculated using a trigonometric formula (Dibble and Bernard, 1980; Villa et al., 2005b). All Upper Paleolithic points interpreted as projectile elements (dart tips or arrowheads) have smaller angles than our points: e.g. shouldered and tanged points of the Gravettian and Magdalenian have angle means of 49.2 ± 12.7 ($n = 36$) and 46.5 ± 4.57 ($n = 40$) respectively. The Solutrean and Magdalenian foliate points have angle means of 54.8 ± 12.5 ($n = 92$) and 46.5 ± 10.1 ($n = 74$). Of all foliate points, the Solutrean bifacial laurel leaves are the heaviest and it has been suggested that the more robust points may have been used as armatures for thrusting spears (Peterkin, 1997); yet their mean angle is significantly smaller ($p < 0.001$) than those of our three sites.

TABLE 5.9. Length (mm) of complete points (convergent scrapers are excluded).

	Mean	SD	Min	Max	<i>n</i>
Bouheben	57.4	14.5	28	96	95
Sibudu, final MSA (layers Ore to Co)	46.9	10.6	30	73	19
Sibudu, layers RSP–MOD	41.8	10.2	24	71	64
Sibudu, layers below RSP	45.3	11.2	28	74	42
Rose Cottage	36.6	8.7	23	60	43

TABLE 5.10. Penetrating angle, i.e. the tip angle seen in plan view and measured in degrees. Convergent scrapers are excluded.

Sites	Mean	SD	Min	Max	<i>n</i>
Bouheben	63.8	9.7	38.6	87.1	107
Sibudu, final MSA (layers Ore to Co)	62.3	13.2	43.6	106.9	36
Sibudu, layers RSP–MOD	68.3	12.7	38.6	95.5	126
Sibudu, layers below RSP	61.9	12.3	31.5	85.5	68
Rose Cottage	62.4	11.3	33	81	50

TABLE 5.11. Impact scars on the Bouheben, Sibudu and Rose Cottage points. Counts exclude convergent scrapers and pieces with broken or damaged distal end. At Bouheben three impact scars occur in layer 2 and three in layer 1¹. The percentage of impact scars on the Rose Cottage points was given as 4.2% (2/47) in Villa and Lenoir, 2006 but it is now updated after a thorough revision of all points conducted in summer 2006; we have included one point with a scar 4mm long in the Rose Cottage sample.

Site	Impact scars (%)
Bouheben (<i>n</i> = 113)	5.3
Sibudu, layer RSP (<i>n</i> = 101)	8.9
Rose Cottage (<i>n</i> = 48)	8.3

Impact Scars

Based on observations of impact scars on projectile points at Paleo-Indian bison kill sites (Fig. 5.7a; Frison, 1974) and experimental work by Fischer et al. (1984) and other researchers (e.g., Barton and Bergmann, 1982; Lombard, 2005a) step fractures, burin-like fractures, and spin-off fractures on the apex of a point, generally longer than 6mm, are considered diagnostic of use as spear tips. Smaller scars at the tip can result from using the tip in a forceful motion. Scars with a negative bulb of percussion have also been excluded as they may simply represent retouch or resharpening of the tip and are uncommon in experiments using points as projectile elements (O'Farrell, 2005). Four tip scars at Bouheben were <6mm and have not been considered in our counts. In the case of Rose Cottage, since points are smaller and length of impact scars is related to mass, we have considered scars 4–5mm in length.

Table 5.11 shows that Sibudu layer RSP, Rose Cottage, and Bouheben have similar proportions of impact scars. Figure 5.10:1–3 and Fig. 5.11 show examples of diagnostic impact scars from Bouheben, Sibudu, and Rose Cottage. We used

frequencies of the RSP assemblage at Sibudu because counts of artifacts from this major layer at the site are complete and thus fully comparable with the Rose Cottage and Bouheben assemblages that have been completely analyzed.

There are very few counts of frequencies of impact scars on spear points, based on complete assemblages from prehistoric sites, to compare with our sites. Published frequencies of impact scars on unifacial points from Sibudu are high (42%), but they are based on a sample selected from 11 post-Howiesons Poort assemblages from the site (Lombard, 2005a). Shea (1988) provides frequencies of impact scars of 7% on Levallois points and other artifacts from Kebara Units IX–XII, but these frequencies are based on counts of wear units on all artifacts, not comparable to our data which are based on counts of individual pointed forms. The only comparable statistics are those provided by Fischer et al. (1984) for Late Glacial, and Holocene assemblages in Northern Europe (Table 5.12). These assemblages consist of projectile points that were delivered by bows. It is not clear to us whether these statistics can be used to generate expectations concerning frequencies of impact scars on points tipping hand-delivered spears. They are, however, what we have. Table 5.12 shows assemblages with very variable proportions of impact scars, from high to quite low, as in our sites. Fischer and colleagues argued that the low proportions of diagnostic impact fractures could mean that the points were not used as weapons, or were made for that purpose but never used. The last explanation seemed more likely to him (see also Lombard, 2005b).

It is important to know whether the assemblage of points comes from a settlement or from a kill site where the main activity was the killing and butchering of animals. This is the case of Stellmoor, an open air site in northern Germany, with an Ahrensburgian layer dated to ca 10,000 BP, containing about 105 whole and fragmented arrows made of pinewood and more than 18,000 remains of reindeer, the results of at least four episodes of hunting drives. The minimum number of reindeer based on the scapula is 302 (Bratlund, 1996; Weinstock, 2000). The arrows consisted of a main shaft with a 20cm long foreshaft. Some foreshafts had simple pointed wooden tips, others were armed with Ahrensburg points (small tanged and obliquely truncated tips), and impact scars are very common (42.2%; Table 5.12). Thirty identified bones, plus two antlers, have lesions with embedded pieces of flint (Bratlund, 1996).

At the Casper site, a Paleoindian bison kill site in Wyoming (USA) approximately 10,000 years old, a minimum of 74 bison were trapped against a parabolic sand dune and killed with spears tipped with a bifacial point (the so-called Hell Gap point) very probably thrown with a spearthrower. Of 60 bifacial points, Frison (1974) mentions that 26 (i.e., 43%) showed impact scars on the distal end, although few details are provided.

At our sites there is clear evidence of a variety of activities that included knapping and manufacturing many domestic (non-weapon) tools in addition to points. Some of the points we studied may have never been used and some, brought back

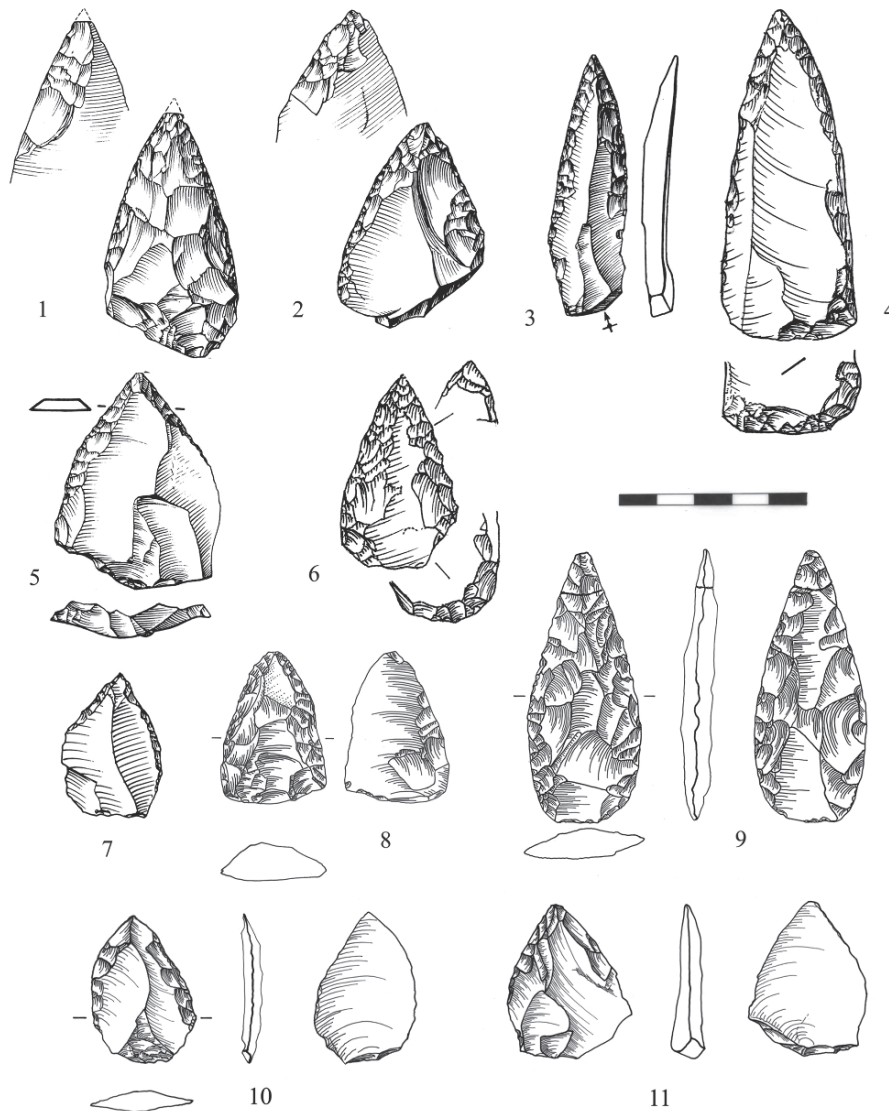


FIG. 5.9. 1–7 points from Bouheben, 3 is from layer 1¹, all others from layer 2; 8 point from Rose Cottage, layer Lou; 9 bifacial point from Sibudu, layer Ore; 10–11 unifacial points from Sibudu, layers Mod and RSP.

with the carcass or on their shaft, may have been recycled, thus removing impact scars (Fig. 5.11: 8).

In other words, we see no reason to expect a high percentage of impact scars on points found at a residential or a manufacturing site. A clear example is provided by one of the localities of the Agate Basin site, a Paleoindian occupation complex at the border of Wyoming and South Dakota. The Main Folsom component of Area II is a residential campsite dated to $10,780 \pm 210$ BP, which has yielded large amount of lithic debris related to weaponry manufacture together with the faunal remains of 11 bison and five pronghorn antelopes. Based on the study of the typical byproducts of the Folsom point manufacture (channel flakes resulting from fluting), a minimum of 38 points were made at the site, yet only three

were discarded (Sellet, 2004). This is not to say that the planning behavior and the technological organization of Middle Paleolithic people were in any way similar to those of the Paleoindian, only that we should keep in mind the possibility that used weapons may not have been discarded in equal proportions at any site.

Discussion

A visual assessment of the Bouheben assemblage would suggest that at least two main design shapes were in the minds of their makers: a broad, thin point with a wide front angle which would produce a greater wound area that would bleed

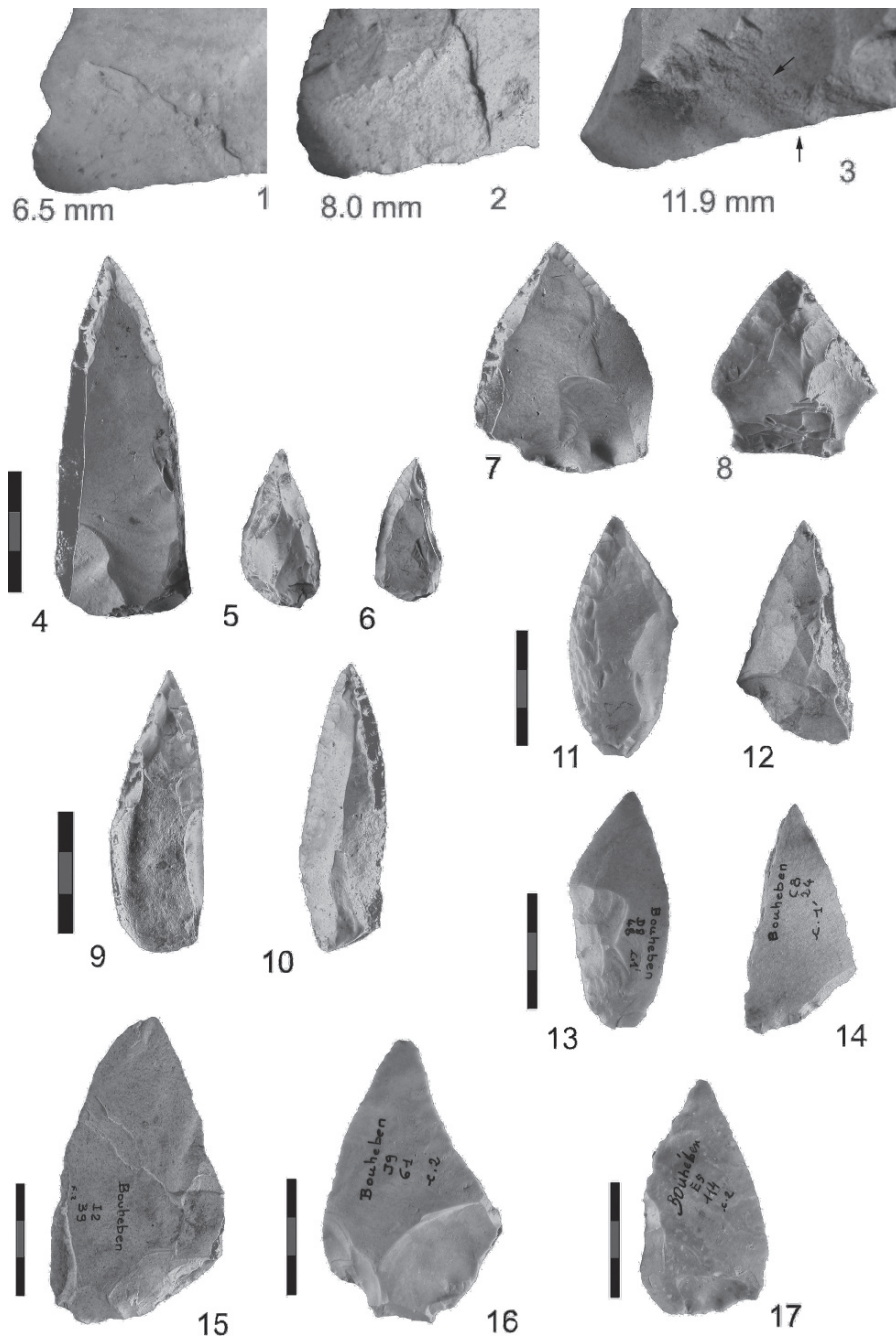


FIG. 5.10. Bouheben. 1–3 impact scars on three Mousterian point, length of scar is indicated on each micrograph: 1–2 step-terminating fractures from layer 2, 3 burin-like fracture, the black arrows indicate the termination of the scar, from layer 1¹; 4–12 Mousterian and elongated Mousterian points: 4–6, 9–11 from layer 2, 7–8, 12 from layer 1¹; 13–15 points with thinned base from layer 2. All points are on flint.

TABLE 5.12. Bronze Age, Mesolithic and Late Glacial assemblages with stone points in Northern Europe. Bromme and Ommelshoved belong to the Brommian culture dated to the Alleröd (about 13,000 BP); Stellmoor, upper level, belongs to the Ahrensburgian and is dated to the Younger Dryas (about 12,000 BP). Age estimates of these climatic periods vary between older and more recent ice core chronologies (Rasmussen et al., 2006). All of these points are interpreted as arrowheads (From Fischer et al., 1984).

Site, age and kinds of points	No. of points suitable for analysis	No. of impact scars	Percentage of impact scars
Muldbjerg about 2800 BC, transverse arrowheads	30	9	30.0
Præstelyng about 3200 BC, transverse arrowheads	56	8	14.3
Vejlebro, level 8 about 3500 BC, transverse arrowheads	24	5	20.8
Vejlebro, level 9 about 3500 BC, transverse arrowheads	42	2	4.8
Stellmoor, upper level, end of the last glacial, tanged points	45	19	42.2
Bromme, end of the last glacial, tanged points	47	3	6.4
Ommelshoved, end of the last glacial, tanged points	88	11	12.5

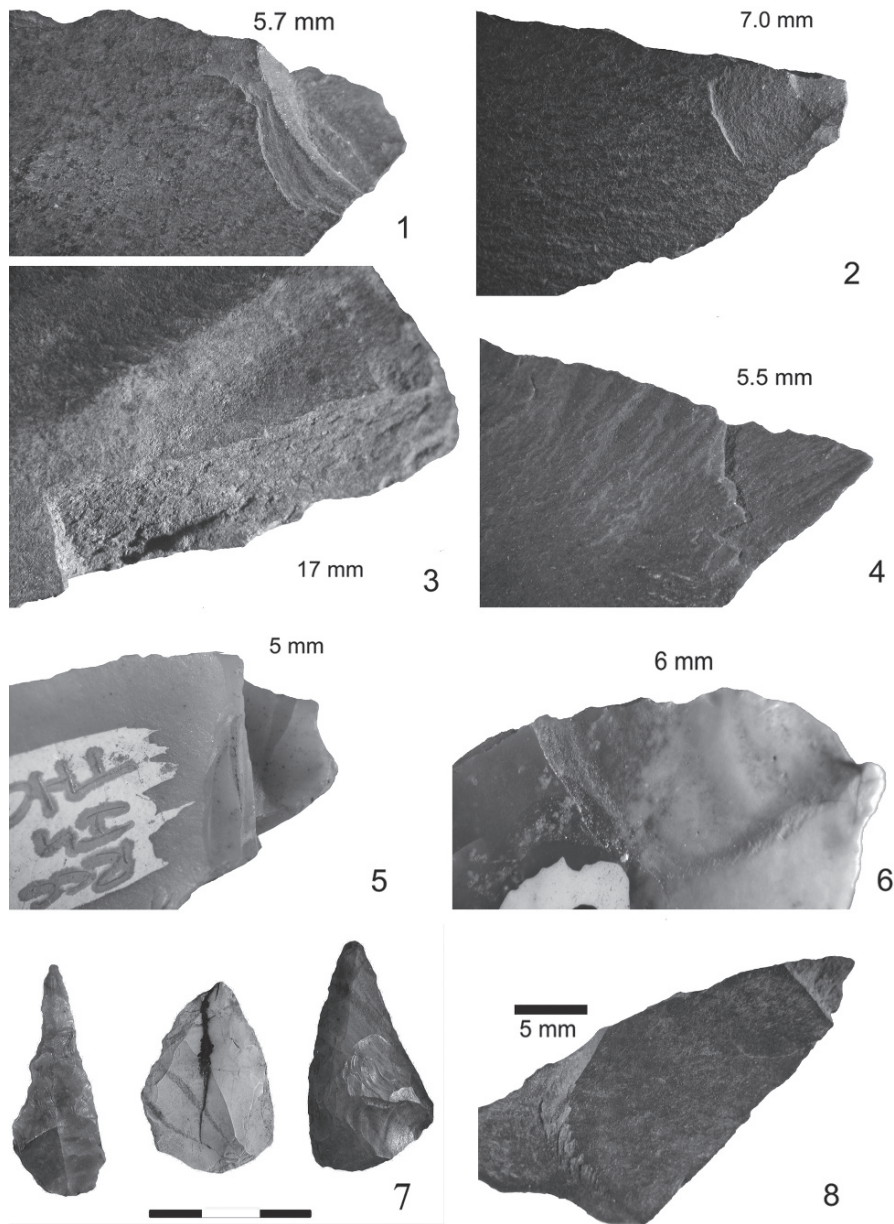


FIG. 5.11. Impact scars on Sibudu (1–4) and Rose Cottage (5–6) unifacial points. 1, 4 from layer RSP; 2–3 from layers above and below RSP, respectively; 5–6 from layer THO. Length of impact scar is indicated on each micrograph. 1, 2, 4 hornfels; 3 dolerite; 5–6 opaline; 7 three unifacial points from Rose Cottage layer THO, the scale is in centimeter; 8 tip retouch flake from Sibudu, layer YSP, showing a 3 mm impact scar at the tip. This flake was removed by direct percussion from a used point, proving that points were occasionally recycled.

easily (Fig. 5.9: 1–2, 5 and Fig. 5.10: 7–8), and a thick point with a slender head and a more obtuse leading edge angle (angle in profile) more resistant to breakage and with more stopping power (Fig. 5.9: 3–4 and Fig. 5.9–10). These shapes show the two contrasting requirements of stone spear points: the need to increase their mass to enhance impact and perhaps durability, and the need to create deep and lasting wounds that would hasten death (Cheshier and Kelly, 2006). A thin point would have the advantage of breaking more easily in the wound, thus protecting the haft from shock and breakage.

Experimental replication shows that the manufacture time of the Leheringen wooden spear was 5–20 times longer than that of the most sophisticated Middle Paleolithic stone implements (such as bifaces and Levallois cores). Depending on the implements used to cut off the twigs and branches from the stem, the time could vary from 4–5 h (if whittling is done by flakes) to about 1 h (if using a chopping implement like a biface). In other words, the making of a wooden spear shaft is much more time-consuming than the making of a Middle Paleolithic point (Veil and Plisson, 1990).

The Bouheben points have repetitive shapes but their variability and intergrading attribute states are such that it does not seem possible (and we have not attempted) to define different types by multivariate analysis. Their variability might be explained, at least in part, by Dibble's (1995) reduction model.

Although the morphometric features and impact scars diagnostic of spear tips are present in our three assemblages, their morphological variability (greater than that observable on the Hell Gap points of the Casper site or the tanged points of the Late Glacial of Northern Europe) suggests to us that some of these pieces may have had other functions, such as use as perforators, scrapers, or knife edges. This is the subject of another paper.

Thrusting or Throwing Spears?

Stone points of the Middle Stone Age/Middle Paleolithic are often interpreted as tips for thrusting spears. According to Churchill (1993), ethnographic sources indicate that the range of throwing spears is in the order of 8 m. This is considered a dangerously close distance for hunting large mammals (Shea, 2006). It is then suggested that Neanderthals used thrusting, not throwing, spears by placing a prey in a disadvantaged position and then killing it at close quarters.

In fact, the range of throwing spears is underestimated. Roman soldiers used javelins (*pila*) that were about 2 m long and weighted 2 kg to a maximum of 3–4 kg for the heavy variety. A *pilum* was made of a wooden shaft with a diameter of 2–3 cm and a length of 1.2–1.5 m; it was topped by a 60–90 cm long iron shank about 7 mm in diameter, leading to a small pyramidal or barbed point. The total length of a *pilum* was 2.0–2.3 m. The thin iron shank would easily pierce a shield or a cuirass and could bend on impact; the barbed point would make it difficult to withdraw from a shield so that the enemy was forced to drop it. Based on modern experiments, the *pilum* maximum range was in the order of 30 m, although the effective range (killing or wounding) was of 15 m. The legionaries threw their *pilum* (each soldier had two) after marching to within 30 m of the enemy, with a second volley at closer range (Goldsworthy, 2002). Some versions of the weapon were weighted by a lead ball to increase penetrative power.

There is no reason to suppose that Neanderthals were less strong than Roman soldiers; they had as much motivation to hit their target (a food animal) as Roman soldiers who had been drilled to obey their centurions and kill their opponents. The world record for throwing javelins in the Summer Olympics is 98.48 m (for a male athlete), but Olympic javelins weigh less than *pila* (800 g for male athletes; the javelin length is 2.6–2.7 m) and the throwing rules, which allow for a run-up of about 33 m, are hardly comparable to those of hunting defensive mammals in search of a caloric return.

In historical times (between the end of the eighth and the fourth century BC) the thrusting spears of Greek hoplites, advancing in phalanx formation to kill at close range, had the same diameter (2.5 cm) as the Roman throwing spear, were

slightly longer (up to 2.7 m) but lighter (up to 2 kg); their shafts, made of dogwood or ash, were not weighted down (Hanson, 1989). In other words, thrusting spears are not necessarily heavier than throwing spears.

The experimental or ethnographic data for throwing spears is limited and does not allow distinguishing between thrusting or throwing spears when only the stone tip and impact scars are available to the analyst. We cannot define the morphometric features that would distinguish between stone points used to tip thrusting or throwing spears, both being used at close or relatively close distance, compared to darts thrown with a spearthrower. Based on data from Australia, darts thrown with a spearthrower in terrestrial environments for hunting or in warfare can reach a distance of 90–135 m; distances for accurate throws range from 45 to 55 m for immobile targets; animals ambushed near water sources are killed by spears usually thrown from 15 to 20 m. Throwing distances of hunting bows are much higher (Cattelain, 1997). Points used to tip darts or arrows have aerodynamic properties (are relatively light, thin, symmetrical, have a narrow penetrating angle and an elliptical cross-section) which do not seem to occur in the heavier points of the Middle Paleolithic and Middle Stone Age. In sum, we cannot say if the stone points of the Middle Paleolithic/MSA were used as tips for thrusting spears or throwing spears. We see, however, no reason for preferring one interpretation over the other; they could have been either.

Ethnographic and historic data suggest that thrusting and throwing spears were used mainly for hunting large and medium size mammals (Churchill, 1993; Hitchcock and Bleed, 1997); the Spartans used thrusting spears to hunt wild boars (Hanson, 1989). These data support a correlation between the preference for large and medium-size mammalian prey of Neanderthals and their weaponry. A similar correlation has been noted between the broadening of the subsistence base with the inclusion of smaller and more agile game in the Upper Paleolithic and the appearance of long-range weaponry in the form of spearthrowers and bows and arrows (Churchill, 1993). Nevertheless, the data available for the European Middle Paleolithic hunting weapons remain very limited and need to be strengthened by analyses of other assemblages, integrating faunal and lithic technology studies. Only then we will be able to fully test this hypothesis.

Conclusions

Our analysis shows that: (a) for the period prior to OIS 9 or 8 very few generalizations can be made about the subsistence behavior of early humans in Europe because the informative sites are few and far between. Nevertheless a good case can be made for hunting from two of the earliest sites in Europe, Gran Dolina TD 6 and Boxgrove; (b) even stronger evidence of hunting comes from sites such as Schöningen and later Middle Paleolithic sites where the topographic setting and the faunal accumulations indicate repeated episodes of hunting the

same species of large-size mammals; (c) evidence for hunting/gathering of very small vertebrates and invertebrates (leporids, birds, fish and shellfish) before the Upper Paleolithic is limited; the available data indicate that Neanderthals relied primarily on herbivore meat and marrow as a dietary resource. This conclusion is supported by isotopic data from collagen extracted from Neanderthal bones (Bocherens et al., 2005). However limited, the evidence of shellfish and small game hunting/gathering shows that Neanderthals were capable of exploiting the same variety of resources as Upper Paleolithic humans.

Morphometric and impact scar analysis of the Bouheben assemblage show that at least some of the Mousterian points were used to arm thrusting or throwing spears. The evidence from La Cotte de St. Brelade suggests that stone-tipped spears were already in use by OIS 6 in Western Europe. Similar weapons were in common use in the MSA of South Africa and the Levant. According to Shea (2006) systematic production of projectile points, thrown with spearthrowers or bows, in the Levant, Europe and Africa dates to after 40–50 ka.

Acknowledgments. We thank Jean-Jacques Hublin and Michael Richards for the invitation to participate in the symposium on The Evolution of Hominid Diets at the Max Planck Institute. Research on the Sibudu and Rose Cottage lithics was funded by grants from the National Science Foundation (BCS 0314371 and BCS 0613319) and the Leakey Foundation to P.V. We are very grateful to Lyn Wadley of the University of Witwatersrand for letting us study materials from her excavations. Lucinda Backwell very graciously lent us her stereomicroscope (an Olympus SZX 9 with a Nikon Coolpix 990) to take photos of the Sibudu and Rose Cottage impact scars. The micrographs of the Bouheben impact scars were done using a Leica 216 APO and a Canon eo5 350D; we thank Eric Pubert of the Bordeaux Institute for his help in using the camera. The Bouheben artifact drawings were done by Pierre Laurent and by Michel Lenoir; those of Sibudu and Rose Cottage were done by Wendy Voorvelt of the University of Witwatersrand with help by Sylvain Soriano. The Bouheben materials are kept in the Institute of Prehistory and Quaternary Geology in Bordeaux; our research would not have been possible without the previous work of the late Claude Thibault, the very careful excavator of Bouheben. Grateful thanks also go to the friends of the Archaeology Lunch in Boulder, especially Jim Dixon, Payson Sheets, John Hoffecker, Steven Holen, Cathy Cameron and Steve Lekson for very valuable comments and discussions and to three anonymous reviewers for their suggestions. This paper was completed in January 2007 and does not include more recent references.

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