



Single carcass of *Mammuthus primigenius* with lithic artifacts in the Upper Pleistocene of northern Italy

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ABSTRACT

This paper presents the find of a *Mammuthus primigenius* carcass and associated Mousterian implements from the Last Glacial site of Asolo, in north-eastern Italy. We review the exploitation of proboscidean carcasses at Lower and Middle Paleolithic sites of Africa, Europe and the Levant, including evidence of elephant killing, and summarize recent research on hafting and use of Mousterian points as spearheads already before the end of the Middle Pleistocene. The bones and implements from Asolo are described in detail; we provide information on other Italian sites with mammoth remains and on the Mousterian record of the north-eastern quadrant of the peninsula. A possible impact fracture has been detected on a Levallois point from Asolo; its interpretation is based on comparisons to similar scars found on spear points of verified function from archaeological sites of later age, and on experimental material. We conclude that the evidence of Asolo is consistent with information from a number of Western European sites supporting a picture of Neanderthals as capable hunters of large game, such as woolly mammoth.

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1. Introduction

1.1. Human-elephant co-existence

Remains of elephants and other proboscideans have been discovered at a number of prehistoric sites of Lower, Middle and Upper Pleistocene age. Humans, at different stages of evolution, have variously cohabited with *Deinotherium*, *Elephas recki*, *Loxodonta atlantica* and *Loxodonta africana* in Africa (Chavaillon et al., 1987; Delagnes et al., 2006; Isaac and Crader, 1981; Klein et al., 2007; Leakey, 1971), with *Mammuthus meridionalis*, *Mammuthus trogontherii* and *Palaeoloxodon antiquus* in Western Asia and Europe (Goren-Inbar et al., 1994; Gaudzinski, 2004; Lister, 2004; Mazza et al., 2006; Mussi, 2005; Palombo and Ferretti, 2005; Santonja and Pérez-González, 2005; Scott, 2007; Villa, 1990; Villa et al., 2005), with *Mammuthus primigenius* in the open grassland biomes of glacial Eurasia (Callow and Cornford, 1986; Hoffecker, 2002; Schreve, 2006; Stuart, 2005; Vasil'ev, 2001), with *Stegodon orientalis* in China (Schepartz et al., 2005), with *Palaeoloxodon naumanni* in Japan (Kondo et al., 2001), with *Mammuthus americanus* and *Mammuthus columbi* in North America (Grayson and Meltzer, 2002;

Haynes, 1991; Surovell et al., 2005; Surovell and Waguespack, in press), with *Cuvieronius* as well as with *Stegomastodon* in South America (Bryan et al., 1978; Dillehay, 1997; Prado et al., 2005; Ranere and López, 2007). In sum, proboscideans of different genera and species were encountered in all continents except Australia. They were adapted to markedly different environments and all shared a dominant position as the largest animals in any given faunal assemblage.

1.2. Subsistence exploitation of elephants in the Lower and Middle Paleolithic

Elephants have long been a resource and the exploitation of carcasses has been suggested at a number of occurrences. Hundreds of archaeological sites, both caves and open-air sites in the Old and New World contain remains of proboscideans (e.g. Gamble, 1986; Haynes, 1991; Lister and Bahn, 2007) so we limit our discussion here to cases of kill or scavenging sites with single or multiple elephant carcasses in the Lower and Middle Paleolithic, that is sites where elephants are the unique or dominant animal of the faunal assemblage.

Human predation has been hypothesized on the basis of a close association of stone artifacts and proboscidean remains at several early sites. In East Africa these occurrences include Olduvai, FLK North level 6 in Bed 1, with one almost complete *E. recki* plus several bones from a second individual, and the *Deinotherium* site

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in Bed 2 (Bunn, 1982; Leakey, 1971; but see Dominguez-Rodrigo et al., 2007), Barogali (Republic of Djibouti; Berthelet and Chavaillon, 2001), Olorgesailie Site 15 (Kenya; Potts et al., 1999) Nadung'a 4 (Kenya; Delagnes et al., 2006) and Mwanganda's Village (Malawi; Clark and Haynes, 1970). The Barogali, Olorgesailie and Nadung'a 4 occurrences record a single *E. recki* each; at Mwanganda the remains were not identified at the species level probably because the bones were in a very bad state of preservation. In Eurasia most of the early occurrences are of *Palaeoloxodon antiquus*. The best known are: Gesher Benot Ya'akov in Israel (Goren-Inbar et al., 1994), Notarchirico in Basilicata, southern Italy (Piperno, 1999; Piperno and Tagliacozzo, 2001), Bucine in Tuscany, central Italy (Mazza et al., 2006), Fontana Ranuccio, Castel di Guido and La Polledrara in Latium, central Italy (Anzidei et al., 1999; Radmilli and Boschian, 1996; Villa, 1991), Ebbsfleet in England (Wenban-Smith et al., 2006), Torralba, Ambrona, Aridos 1, Aridos 2 and Arriaga Ila in Spain (Freeman, 1975, 1978; Santonja et al., 1980, 2001; Santonja and Villa, 1990; Villa, 1990; Villa et al., 2005). Note that Torralba and Ambrona, Fontana Ranuccio, Castel di Guido and La Polledrara, are multiple carcass sites.

Association of elephant bones and artifacts is also documented at a number of early Upper Pleistocene sites. At Gröbern (Germany) the bones of an adult male *Palaeoloxodon antiquus*, 35–40 years old, were associated with 26 artifacts (mainly unretouched flakes) in a lakeside setting dated to MIS 5e (Gamble, 1999; Weber, 2000). *Mammuthus primigenius* bones belonging to a minimum number of individuals of 11 and Middle Paleolithic artifacts (including 47 ovate or subtriangular handaxes in fresh condition) dating to the early MIS 3 occur in a paleochannel at Lynford (Norfolk, England). However, taphonomic analysis of the vertebrate assemblage which includes also reindeer (MNI = 8), horse (MNI = 2) rhinoceroses (MNI = 4) and some carnivores shows that the assemblage was a palimpsest. Specimens have different depositional histories with varying degrees of weathering, breakage and abrasion; evidence for direct faunal exploitation by Neanderthals cannot be unequivocally identified (Schreve, 2006). Two important sites, La Cotte (MIS 6) and Leheringen (MIS 5e) are discussed below in the section "Hunting and killing elephants".

1.3. Butchery and bone breakage

With the exception of two sites (La Cotte and Leheringen) none of these Lower and Middle Paleolithic sites provide good evidence of hunting; in some cases hominids may have butchered remains from natural deaths. Ambrona, La Polledrara, Lynford and other sites with multiple elephant carcasses appear to be a complex mix of natural and human components; some of the faunal remains represent natural occurrences without any clear evidence of hominid intervention. Direct evidence of butchery can be provided by SEM verified cutmarks made by stone tools and anthropic bone fractures, but it is rare at all these early sites.

Cutmarks on some ribs and a distal end of a humerus were reported as "probable" at FLK North level 6 by Bunn (1982). They have now been reinterpreted as abrasion striations (Dominguez-Rodrigo et al., 2007). Cutmarks on one rib have been only briefly reported from Olorgesailie Site 15 (Potts et al., 1999: 768). SEM verified cutmarks on an elephant skull and long bones have been documented at Ambrona but they are very few (Shipman and Rose, 1983; Villa et al., 2005). Cutmarks on three woolly mammoth tusks from layer 3 at La Cotte have been similarly documented; they occur at the proximal base of the tusks, where the tusk leaves the bone sheath of the skull. One tusk at Ambrona had an oblique mark on its midsection and similar striations were observed on other tusk fragments from the site (Villa and d'Errico, 2001; Villa et al., 2005). These marks are likely to be produced by the animals themselves using tusks in a variety of activities. However the La

Cotte marks are in areas covered by the animal skin and are best interpreted as having been made in the course of butchery (Jones and Vincent, 1986).

In all, however, very few cutmarks have been reported from a handful of sites; even when present, their frequency is extremely low. The scarcity of cutmarks may be due in large part to the weathering and postdepositional alteration of bones which may have removed the evidence of butchery. Elephant bones are often in bad state of preservation (e.g. the *Deinotherium* site, Barogali, Olorgesailie, Nadung'a 4, Mwanganda, Notarchirico, Ebbsfleet, Ambrona and La Cotte). Moreover cutmarks on elephant bones appear to be less common than on smaller animals because the periosteum and articular cartilage are very thick; stripping of meat can be accomplished without leaving tool marks because of the thickness of the tissues (Haynes, 1991). Actualistic data on modern elephants butchered with metal knives and axes record a low frequency of butchery marks (15.3% of cutmarks and chopping marks; Crader, 1983). Carcasses were extensively processed and partly destroyed to extract bone grease among the Efe and Lese of the Ituri forest, thus frequency of cutmarks could not be recorded (Fisher, 2001). In general, absence of butchery marks does not necessarily mean that butchery did not take place.

At most Paleolithic sites butchery is generally indicated by breakage of bones for marrow. Yet breakage of elephant long bones for marrow does not appear to have been a common practice at any of these Lower and Middle Paleolithic sites (cf. a detailed discussion in Villa et al., 2005: 246). The explanation may lie in the fact that elephant bones do not contain marrow in the usual form. To release the marrow filling the canals in cancellous bone it is necessary to heat or boil the bones (as the Efe did) or have containers to collect the draining liquid if the long bones are exposed to the sun (Clark, 1977). Exceptions are found at a few sites but there it seems that elephant bones were broken for the purpose of making flaked tools, as at Olduvai Bed II, Castel di Guido and La Polledrara (Backwell and d'Errico, 2004; Villa et al., 2005). Breakage of mammoth skulls in the parietal region presumably to extract the brain is reported from La Cotte (Scott, 1986), and equivalent damage just below the nasal cavity is also reported on the Gesher Benot Ya'akov elephant skull (Goren-Inbar et al., 1994).

1.4. Elephant bones as raw material in the Lower and Middle Paleolithic

There is positive evidence of the use of elephant remains for purposes other than subsistence. In the Lower Paleolithic implements ranging from expedient tools to fine bifaces were produced by direct percussion on elephant limb bones at several sites in the Latium region and Germany, the earliest examples being in Eastern Africa at Olduvai Bed II (Backwell and d'Errico, 2004; Gaudzinski et al., 2005; Tromnau, 1983; Villa, 1991; Villa et al., 1999; Villa and d'Errico, 2001). Intentional modification of several elephant ribs and fibulae through whittling to produce a point is reported from the Middle Paleolithic site of Salzgitter-Lebenstedt (Gaudzinski, 1999; Gaudzinski et al., 2005). In Eastern Europe during the Middle Paleolithic mammoth bones and tusks seem to have been used to build simple structures, such as windbreaks, lacking the complex arrangements of Upper Paleolithic dwellings (Hoffecker, 2002; Iakovleva and Djindjian, 2005).

1.5. Hunting and killing elephants

The evidence for hunting and killing elephants is limited. In one case faunal analysis and contextual evidence strongly suggest that hunting took place. At La Cotte de St. Brelade (Jersey, English Channel Islands) layers 3 and 6, dated to MIS 6 by TL dates and stratigraphic data, contain two separate accumulations of bones of

Mammuthus primigenius (total MNI = 18) and *Coelodonta antiquitatis* (woolly rhinoceros; total MNI = 5). 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 bottom of a deep ravine (about 30 m deep 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 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).

At Lehringen, a Last Interglacial (MIS 5e) site in eastern Germany a spear, made of yew wood, was found among the ribs of an adult *Palaeoloxodon antiquus*, together with 25 stone artifacts. The spear was 2.39 m long, its diameter was 3.1 cm at the base and 2.0 cm near the tip; its weight is concentrated on the proximal end, thus its use as a thrusting spear is a reasonable inference (Thieme and Veil, 1985).

2. Asolo and the Italian woolly mammoths

Elephant remains are common finds in Italy, both at palaeontological and at archaeological sites. During the Middle and early Upper Pleistocene, most occurrences are of *Palaeoloxodon antiquus*, often extensively preserved (Palombo and Ferretti, 2005; Palombo and Mussi, 2001). During MIS 4 and 3, the rarer *Mammuthus primigenius* is part of the record in the northern and central part of the peninsula and even, in one instance, in southern Apulia; 13 localities (some consisting of several sites in a wide area) are listed by Palombo and Ferretti (2005; see also Mussi, 2001). To this list, we can add two more localities: Vidor in the Veneto region (Fig. 1; Reggiani and Sala, 1992), and Veroli in Latium (M.R. Palombo, pers. comm.). Mammoth remains are scanty and fragmentary with the exceptions of two partial skeletons discovered at Vidor and Asolo,

both in the province of Treviso, in the Veneto region. The latter find near the hamlet of Pagnano, is the more interesting because it is one of the only three Italian sites with woolly mammoth remains where Mousterian tools have also been found, the other two being Riparo Tagliente, in the same general area, and Buca della Lena in Tuscany. At a fourth archaeological site, the Arene Candide cave in north-western Italy, the remains are associated with a Gravettian industry. Carved mammoth ivory is rarely documented in Italy: a few ornaments and female figurines only exist in Gravettian sites of Liguria, close to the modern boundary with southern France, and they could well have been imported from some distant area (Mussi et al., 2000). Direct C14 dates on mammoth bones, when available, confirm that mammoths were present in Italy during MIS 3: the specimen from Veroli is dated to c. 39 ka (M.R. Palombo, pers. comm., 2008), while at Settepolesini (near Ferrara) it is later, with a date of $35,800 \pm 500$ and $33,830 \pm 690$ B.P. (Stuart et al., 2002). These are the latest available dates for Italy, a single exception being the few proboscidean bones found at the Arene Candide Cave (Liguria) in Gravettian layers (Cassoli and Tagliacozzo, 1994). The bones (a second phalanx, a possible fragment of a patella, an undetermined epiphysis fragment and two shaft splinters) are undiagnostic and have been attributed to *Mammuthus primigenius* since *Palaeoloxodon antiquus* was supposedly already extinct at the time (Stuart and Lister, 2007). *Mammuthus primigenius* of course survived well into MIS 2 in France (Stuart, 2005); it may be significant that the northwestern littoral margin of the Italian peninsula offers a route of entry to animal migration from southern France into Liguria. The latter region is separated from the Po Valley by the Ligurian Apennines and belongs to a different drainage system, with rivers exiting into the Tyrrhenian sea, in opposite direction from the Po river which exit into the Adriatic. Thus the possible presence of mammoth at this late date in Liguria need not imply that it also existed in other parts of the Italian peninsula.

3. The Asolo mammoth

The find from Asolo (Fig. 1) was first reported in detail by Dal Piaz (1922), but has not attracted attention in the literature (but see Mussi, 2001; Fiore et al., 2004). (Figs. 1–3) The skeletal remains have been recently re-studied and assigned to an adult female *Mammuthus primigenius*, c. 32–35 years old (Reggiani, 2005; Reggiani and Sala, 1992).

The mammoth was originally discovered by a local scholar, Pacifico Scomazzetto (1831–1888), a chemist and self-taught historian and archaeologist. Digging into the sandy gravels of a small stream, the Erega, next to its confluence with the Musone, an affluent of the Brenta River, he unearthed fossils and lithic implements (Dal Piaz, 1922). The alluvial deposits of the Erega are now dated to the Last Glacial (Venzo, 1977). The bones, belonging to a single individual, as well as the associated tools, were carefully preserved, eventually ending in the collections of the Geology and Paleontology Museum of the University of Padova, where they are currently on display, together with five flint artifacts.

The mammoth remains from Asolo are as follows (Reggiani and Sala, 1992; Reggiani, 2005 and pers. comm., 2008; Fig. 2):

- Left and right third upper molars (Fig. 3)
- One occipital condyle
- Right tusk
- Three thoracic vertebrae and fragments of four others, two caudal vertebrae, plus two vertebral centra; their rank is undetermined.
- Five left ribs, two right ribs; their rank is undetermined.
- Left and right scapulae, both fragmented
- Right radius (missing the distal epiphysis and part of the shaft)
- Right ulna (missing the distal epiphysis and most of the shaft)

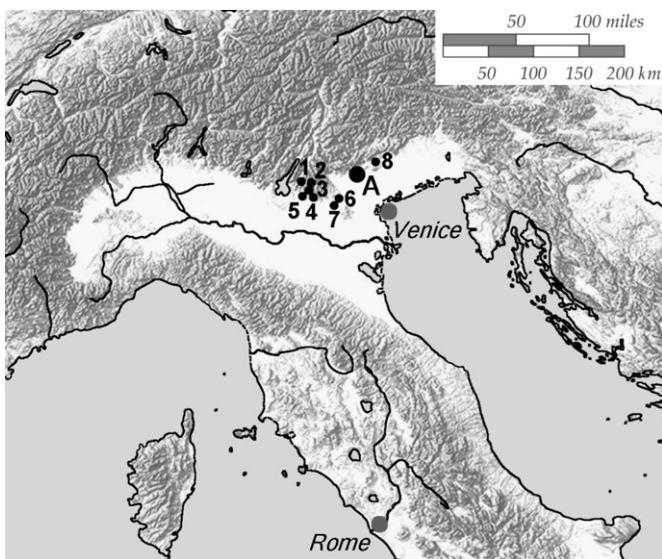


Fig. 1. Map of northern and central Italy showing the location of the sites in the Veneto region mentioned in the text: A) Asolo; 1) Grotta di Fumane and Grotta della Ghiacciaia; 2) Grotta A di Ponte di Veia; 3) Riparo Tagliente; 4) Riparo Mezzana and Riparo Zampieri; 5) Grotta di Santa Cristina; 6) Grotta del Broion; 7) Grotta Minore and Grotta Maggiore di San Bernardino; 8) Vidor. Map base copyright © 2000–2001, Ancient World Mapping Center (<http://www.unc.edu/awmc>) used by permission.

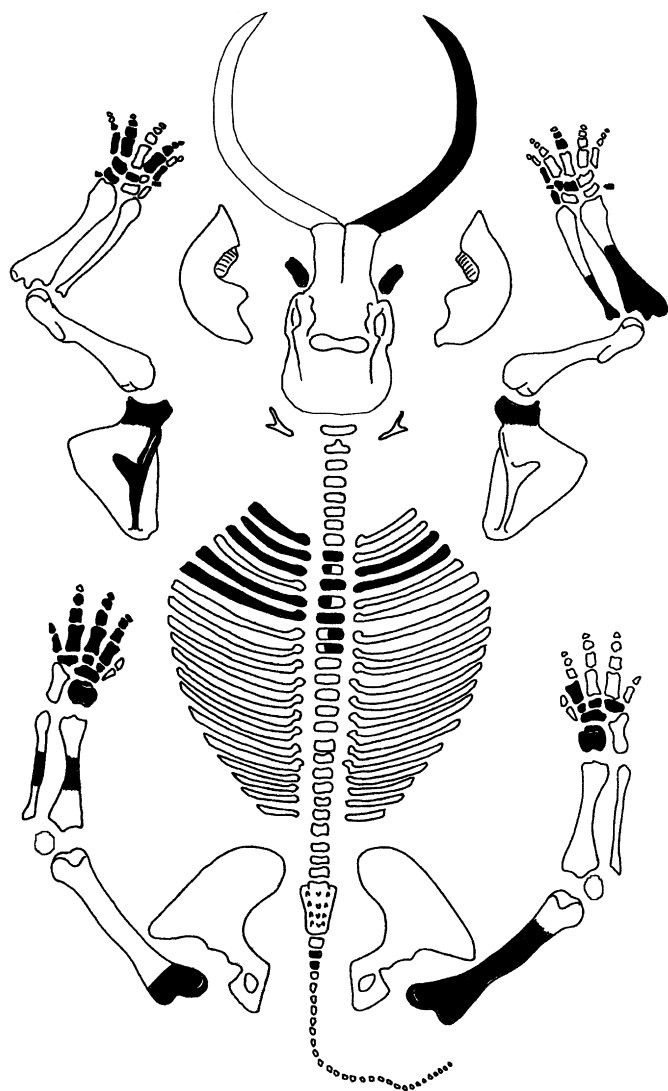


Fig. 2. Schematic mammoth skeleton. Bones present at Asolo are indicated in black; bones in outline are missing. The upper third molars are indicated on both sides of the skull; the occipital condyle cannot be indicated in this view.

- Eleven of 16 carpals
- Five of 10 metacarpals
- Eight of 28 phalanges of the manus
- Left and right femurs, both incomplete
- A shaft fragment of the left tibia
- A shaft fragment of the left fibula

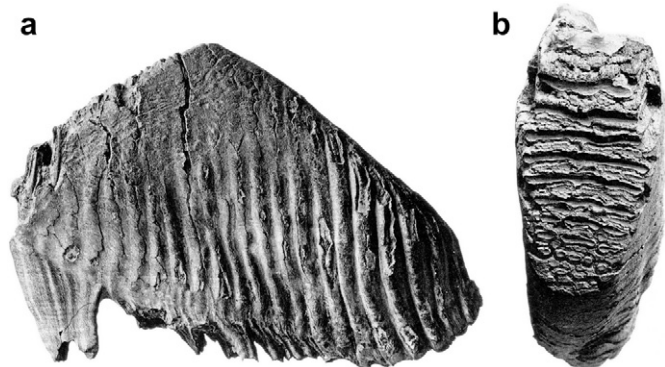


Fig. 3. Left molar of the Asolo mammoth; a: lingual view; b: occlusal view.

- Ten of 14 tarsals
- Five of 10 metatarsals
- Nine of 28 phalanges of the pes

The bones are unabraded and in fairly good state of preservation but there is some excavation damage. Two of the ribs have striations that appear to be curator marks as many bones were consolidated with fish glue, later partly removed. Two of the proximal epiphyses of the ribs show some very slight abrasion, probably due to water flowing on the exposed parts of the bones, only partly buried in sediments. We have seen no evidence of anthropic fractures and no true cutmarks.

4. The stone artifacts

All the artifacts are in very fresh condition with sharp edges but were partly damaged when discovered; the recent fractures and edge damage are documented by the detailed pictures of Dal Piaz (1922), (Figs. 4 and 5). Two different kinds of good quality raw material were used: a reddish flint, which was not completely patinated, and an extensively patinated gray flint, with some discontinuously silicified zones (Fig. 4).

1. Unretouched Levallois point, with a faceted platform (but without individual preparation), trimming of the platform edge and a moderately protruding bulb. There is excavation damage on the right side (proximal and distal). Grey flint with a glossy black patina. L = 64.9, B = 37.7, Th = 9.0 mm. Catalogue no. 26671a.
2. Unretouched Levallois point, with a plain platform, trimming of the platform edge, and prominent bulb. Excavation damage on the left side and a very small recent fracture at the tip. Reddish flint with a discontinuous glossy black patina. L = 54.3, B = 28.9, Th = 9.0 mm. Catalogue no. 26671b.
3. Unretouched Levallois flake, with a faceted platform, trimming of the platform edge, and a weakly developed bulb. There is some patinated irregular retouch at the left proximal end, and recent pseudo-retouch on the left side. Reddish flint with a discontinuous glossy black patina. L = 37.7, B = 39.3, Th = 6.6 mm. Catalogue no. 26671c.
4. Proximal flake fragment with a faceted platform, irregular trimming of the platform edge and a prominent bulb. Reddish flint with a discontinuous glossy black patina. The length and breadth measurements are incomplete. L = 31.3, B = 28.6, Th = 9.0 mm. Catalogue no. 26671d.

A fifth flake (Fig. 5) appears to have an impact fracture at the tip. This is an unretouched Levallois point with a dihedral platform and a moderately protruding bulb, of grey flint with a glossy black patina. L = 52.5, B = 37.1, and Th = 8.2 mm. Catalogue no. 26671e. There are recent unpatinated pseudo-retouches (damage probably caused by the excavation tools) on the left side, and close to the distal end on the right side. There is a small step fracture 0.8 mm long at the tip, on the ventral face, which we interpret as a possible impact scar due to the use of the point as a spearhead. Given the very small size of the scar we need to go into some detail about interpretations of impact scars and evidence of stone-tipped spears in Mousterian times.

4.1. Impact fractures

Our understanding of impact fractures is based on observations of impact damage on Paleolithic bifacial points at various bison kill sites based on the pioneer work of George Frison and Bruce Bradley (Bradley, 1982; Bradley and Frison, 1987; Frison 1974, 1991; Frison and Bradley, 1980) and on experimental material developed by

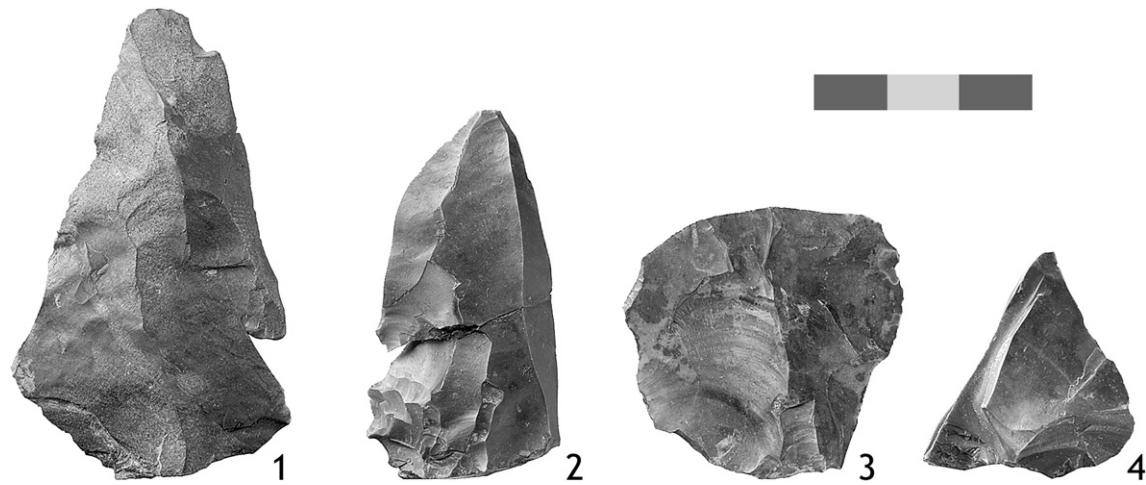


Fig. 4. Four stone artifacts from Asolo. Scale bar = 3 cm.

a group of French researchers led by Jean-Michel Geneste and Hugues Plisson for the functional analysis of shouldered and unifacial Solutrean points (Geneste and Plisson, 1990, 1993). Thus we have been able to have access to both experimental and archaeological materials of verified function and made on raw materials (flint, chert) similar to the Asolo flint.

Observations by Frison, (1974) and experimental work by Fischer et al. (1984) and by other researchers such as Bergmann and Newcomer (1983), Odell and Cowan (1986) and O'Farrell (1996, 2004) has suggested that step-terminating fractures, burin-like fractures and spin-off fractures (Fischer et al., 1984, Fig. 5; see also the definitions of the Ho Ho Committee, 1979) on the distal end of a point are diagnostic of use as weapon tips. Impact damage also occurs on bases but we are not concerned with it here.

According to Fischer et al. (1984) only spin-off fractures with a length of 6 mm or more should be considered diagnostic of impact for large points like the Brommian points (Late Glacial) he replicated and used in his shooting experiments (a large Brommian point is comparable in size to a Levallois point). He does not suggest a length limit for step-terminating fractures, nor does O'Farrell (2004). Step-terminating fractures have not been obtained in trampling experiments (O'Farrell, 1996) hence they are considered diagnostic regardless of size. For these reasons we interpret the scar on the Asolo Levallois point as possibly due to impact.

Due to its small length, the scar might be considered not significant. In this respect it is worth considering another kind of damage, also of very small size. Crushing of the tip – an impact damage consisting of a cluster of overlapping small step fractures parallel to the long axis of the point – was first defined by Frison (1974) and illustrated by Odell and Cowan (1986: Figs. 2c,f and 3c) but was not described by Fischer et al. (1984). We have personally

observed this damage on points of verified function. Crushing occurs in at least two cases (two/55 observed) in the Geneste and Plisson experiments, and on two Paleoindian points from the Frazier bison kill site in Colorado (two/10; Slessman, 2004). Crushing damage is of very small size, extending 2–4 mm in length, and it might be excluded from consideration if using the limits suggested by Fischer et al. Yet the cause of the damage is without doubt and its features should not be confused with edge damage caused by trampling which causes abrupt microscars and microfractures, also smaller than 5 mm in maximum dimension but perpendicular to the edge of the artifact (Villa and Soressi, 2000). According to Bradley (pers. comm., 2007) crushing damage could easily be the result of impact on an animal tough skin.

4.2. Mousterian spear points

Traces of hafting on Mousterian points and convergent scrapers have been observed by microwear studies (Anderson-Gerfaud, 1990; Beyries, 1988; Villa and Lenoir, 2006 and further references therein). Direct evidence that hafting technology was practiced in the Upper and even in the Middle Pleistocene by Neanderthals has been provided by finds of birch-bark tar on the proximal part of two flakes associated with a *Palaeoloxodon antiquus* at the site of Bucine in central Italy dated to MIS 6 by rodent biostratigraphy (Mazza et al., 2005). Comparable – if younger – evidence comes from the Middle Paleolithic site of Königsau in Germany, with finds of two pieces of birch-bark pitch with imprints of a wooden haft and of retouches from the edge of a bifacial tool from two layers dated to about 48 and 43 ka (Grünberg, 2002). These organic materials – pitch and tar – were obtained by distillation with combustion at relatively low temperature (Grünberg, 2002: 16). Traces of bitumen



Fig. 5. Unretouched Levallois point and microscope photo of the step fracture at the tip. The scale bar of the whole artifact = 3 cm; the scale bar of the microscope photo = 1 mm.

for hafting on the proximal part of three Levallois flake, one convergent scraper and one cortical flake have been found in Mousterian levels dated to ca. 60 ka at the site of Umm el Tlel in Syria (Boëda et al., 1996). Less direct evidence of hafting based on an unusual patina pattern had been observed – and experimentally reproduced – on a Mousterian scraper from the site of Quneitra (Israel) dated to 54 ka (Friedman et al., 1994–1995).

Use of Mousterian points as spearheads is strongly supported by the discovery of a mesial fragment of a Levallois point embedded in the third cervical vertebra of a wild ass again from Umm el Tlel (Boëda et al., 1999). One of us has recently published evidence of impact scars on Mousterian points from Bouheben, a Middle Paleolithic/Final Acheulian site in SW France (Villa and Lenoir, 2006; Villa and Lenoir, in press), supporting previous observations of impact scars on Mousterian points from the site of La Cotte de St. Brelade (Callow and Cornford, 1986) dated to MIS 6, and interpretations of Levallois points in the Levant as spear points by the morphometric analyses and experimental work of John Shea (Shea, 2006 and references therein).

4.3. Assemblage size

The small number of artifacts from Asolo comes as no surprise. Bucine, a carefully excavated site with sediment screening yielded only three flakes in association with the incomplete skeleton of a young straight-tusked elephant. Gröbern, Lehringen and Aridos 2 yielded 26, 25 and 34 artifacts respectively. Higher numbers of artifacts at single carcass sites are often due to knapping in situ producing large numbers of small flakes and fragments, e.g. Ebbsfleet with 100 artifacts, Mwanganda's Village with 314 artifacts and Aridos 1 with 331 artifacts. At sites that have yielded even larger quantities such as La Cotte layer 3 with 1185 artifacts (Callow and Cornford, 1986: 203), Olorgesailie Site 15 with 2322 artifacts (Potts et al., 1999) and Nadung'a 4 with more than 6000 artifacts (Delagnes et al., 2006) other kinds of activities may have taken place.

5. Age of the site

As mentioned above, the deposit of Asolo is dated to the Last Glacial by geological correlations (Venzo, 1977). New geological studies might provide more precise information; note, however, that the findspot of the Asolo mammoth can no longer be precisely located due to soil disturbances in the area (Reggiani, pers. comm., 2008). No artifacts have ever been reported in the overlying deposits. The feasibility of a direct C14 date of the mammoth remains had been discussed some years ago by paleontologists Reggiani and Sala with the Padova Museum curator, but eventually dismissed because consolidants of animal origin (fish glue) had been used to preserve the bones. Modern contamination is to be expected, resulting in a ^{14}C age substantially too young. Samples of the Vidor mammoth had been taken but no date has yet been published; however the Vidor mammoth was not associated with artifacts. For the Asolo mammoth dating with improved pre-treatment methods, notably ultrafiltration (Stuart and Lister, 2007) might be successful but it is not yet available.

The Levallois implements associated with the Asolo mammoth fit well into either MIS 4 or 3. Mousterian industries of Levallois facies and of Last Glacial age are amply documented 50–80 km south-west of Asolo, in the lower Monti Lessini and in the Colli Berici. A number of caves and rock shelters have been excavated there in the last 50 years, and dated through paleontology and geostatigraphical correlations, as well as through ^{14}C , TL, ESR and $^{234}\text{U}/^{230}\text{Th}$ methods. Grotta di Fumane, Grotta della Ghiacciaia, Grotta A di Ponte di Veia, Riparo Tagliente, Riparo Mezzena, Riparo Zampieri, Grotta di Santa Cristina, all cluster in the Monti Lessini,

while Grotta Maggiore and Grotta Minore di San Bernardino, as well as Grotta del Broion are in the Colli Berici (Fig. 1). All have occupation levels of MIS 4 and MIS 3 age (Bartolomei et al., 1980, 1982; Bertola et al., 1999; Cremaschi, 1990; Fiore et al., 2004; Longo et al., 2003; Peresani, 1998, in press; Peresani et al., submitted for publication). The Mousterian industries are characterized by the Levallois technique and are homogeneous in the whole area (Peretto, 1992; Peresani, 2001). At open air sites, where assemblages are usually of small size (like at Asolo) Levallois artifacts are dominant (Peresani, 2001). At Riparo Tagliente two fragments of enamel lamellae of a young *Mammuthus primigenius* were found associated with Mousterian tools (Fiore et al., 2004). Riparo Mezzena also yielded Neanderthal remains with a well preserved DNA sequence, suggesting fair complexion and red hair (Lalueza-Fox et al., 2007).

6. Conclusions

The lack of direct human intervention on the mammoth bones and of more detailed information on the context does not allow us to make a definitive interpretation of the finds at Asolo. However, a number of factors support a hypothesis of mammoth-human interaction: the artifacts are in very fresh condition, the mammoth bones show very limited weathering, there is no evidence to suggest postdepositional disturbance or trickling down of artifacts from overlying deposits, and one of the artifacts shows impact damage. We believe that there is enough evidence to suggest that Neanderthals in Italy exploited mammoths and may have used a stone-tipped spear to kill one of them. Isotopic data from two Neanderthal sites in France (Saint Césaire and Les Pradelles) support the picture of western European Neanderthals capable of hunting large prey as woolly mammoth on a regular basis (Bocherens et al., 2005).

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