THE FAUNAL REMAINS FROM THE MAGDALENIAN DEPOSITS IN SECTORS P16 AND I11 AT SOLUTRÉ

GENERALITIES ABOUT THE SECTOR P16 AND I11 SITES

A total of 95 m^2 of Magdalenian deposits in sector P16 was excavated in a series of campaigns between 1968-1974. A rich find assemblage comprising 4,159 faunal remains and over 1,100 Magdalenian lithic artefacts was recovered during this period from the site. The large amounts of bone of horse and several anatomically connected segments of horse carcasses gave a general impression by the end of the excavation period that sector P16 had been used primarily as a horse butchery site.

The location of the site on a slope, indications from sedimentological analyses that sediments accumulated during a series of depositionary events, the distribution of the bulk of the finds within a channel, evidence of movement of finds down the slope, and lack of patterning in the distribution of humanly or carnivore modified bones, strongly suggest that the spatial distribution of the bones revealed during excavation is the product of a series of post-depositional processes which took place over a long period of time, rather than the *in situ* remains of a butchering site.

Conjoin lengths between fragments of bone show that material moved over a distance of up to four metres down the slope and, based on this information, it is quite possible that the butchery site – or sites – from which this material originated, was located further upslope towards the base of the southern cliff of Solutré rock. A concentration of charred bone fragments in the northern section of the channel, and site reports describing a hearth in roughly the same area, are the only pieces of evidence which could suggest that an activity – in this case humans lighting a fire – had actually taken place at sector P16.

The sondage in sector I11 (quadrats 69, 79 and 89) was excavated in 1987 as part of a programme of sampling for sedimentological studies. Although less than two square metres in size, excavations at this site produced finds from five cultural horizons, the richest of which belonged to the Magdalenian period. The location of the site on the slope of the hill below the Roche de Solutré and the presence of long bones embedded vertically in the deposits led Combier to the conclusion that the finds in the Magdalenian horizon had probably accumulated at the site as a result of solifluction and movement of material down the slope, a conclusion that was supported by the results of a study of conjoining bones undertaken during the course of this analysis.

Columns of samples for pollen were taken twice during excavation of the P16 site. The most significant sample, Solutré B, yielded low values of arboreal pollen dominated by pollen of pine, indicating cold climatic conditions. Low values of thermophilous taxa such as lime, hornbeam and walnut show that the climate was not extremely cold. Herbaceous pollen was found in all the samples, grasses were rare and the presence of some Chenopodia indicated open terrain at the site. It was concluded that although the pollen remains could not be used to date the site exactly, the »temperate« climatic conditions indicated in the pollen diagram, combined with the age of the bone dated by the Lyon laboratory (see below), indicated deposition of the find-assemblage during the Bölling Interstadial.

During excavation of the P16 site a bone was submitted to the C^{14}-laboratory at Lyon for dating: the find was dated to 12,580 ± 250 BP. A cut-marked horse tooth from P16 and a cut-marked horse calcaneum from sector I11 were submitted during the course of the current analysis to the Accelerator Unit in Oxford which produced older C^{14}-dates of 15,080 ± 130 BP and 14,570 ± 130 BP respectively for the new samples. The differences between these dates and the date produced by the Lyon laboratory could be due to the different methods of dating used, or indicate that deposition of finds at P16

took place over a long period of time. It is however clear, that neither the Lyon date nor the Oxford dates place deposition of bone at sector P16 into the short, temperate phase known as the Bölling Interstadial. According to a chronology of the Upper Weichselian established by Lanting and van der Pflicht (1996), the short temperate Bölling Interstadial sensu stricto begins at around 12,500 BP. A date of 12,580 BP places the bone sampled by the Lyon laboratory into Lanting and Pflicht's older Dryas I/Bölling (sensu lato). The older date produced by the Oxford laboratory suggests deposition of cut-marked horse remains in the period between the Pleniglacial and the Late Glacial Interstadial Complex.

A total of 4,159 faunal remains was seen and recorded during the present analysis of the sector P16 faunal assemblage. 4,133 of these finds were attributed to the Magdalenian fauna. These bones were well-preserved with varying stages of root-etching. The Magdalenian fauna consisted of 93 finds which were too fragmentary to be identified to a species, three bird bones, five bones from small carnivores (?) and a very worn tooth, probably from a lion. The remaining 4,031 bones could be definitely identified to a species and this assemblage is dominated by horse, but the remains of other animals, reindeer, bison, wolf, fox and wolverine, are also present. Of the 528 bones recorded from the Magdalenian deposits in sector I11, 500 finds could be identified to specific level and two finds to generic level.

The composition of both faunas with large herbivores such as horse and bison indicating a predominantly open, herbaceous environment, and reindeer indicating cold climatic conditions, is comparable to that deduced from pollen analysis.

The species present in the P16 and I11 faunas were separated into an archaeological faunal group and a non-archaeological, or »background«, faunal group, based on the presence or absence of traces of human modification of the bones such as cut-marks, hammerstone-induced impact notches or evidence of use of bone and antler as a raw material to produce tools. At P16 human modification was observed on the remains of horse, reindeer, bison and possibly wolf. At I11, human modification was only observed on the bones of horse and reindeer. In the following section, aspects of the remains of the three main species, horse, reindeer and bison are compared.

A COMPARISON OF THE REMAINS OF THE THREE MAIN SPECIES – HORSE, REINDEER AND BISON – AT THE SECTOR P16 AND I11 SITES

Numbers of finds and numbers of individuals

Horse dominates the fauna from the Magdalenian deposits at P16 with a total of 3,577 finds or 88.7% of the total number of bones identified to a species. The remains represent some 2,672 skeletal elements from this species. A minimum of 45 individuals of horse was recorded on the acetabular portion of the pelvis. A much lower quantity of finds was identified as reindeer remains. 271 finds were identified to this species, comprising 216 elements and representing 6.6% of the total number of finds identifiable to a species. A minimum of nine individuals of reindeer, counted on nine left astragali, was recorded at P16. Large bovids, identified by morphological criteria as bison, were represented by only 142 finds, comprising 119 elements and 3.5% of the total number of finds identifiable to a species. A minimum of five individuals of bison was counted on five left metacarpals, but a more detailed analysis of the bison remains, using the minimum number of individuals as a basis, but also including counts of individual animals identified by tooth wear and eruption stages and post-epiphyseal fusion stages of bones, produced a total of at least seven individuals of bison at the site.

Horse is also the dominant species at sector I11, representing 92.8% of the total number of remains attributable to a species at this site. A minimum of six individuals was counted using conventional

methods, but a more detailed analysis of upper cheek teeth of this species produced a higher minimum number of nine individuals. Reindeer bones and teeth formed only 5.7% of the remains identifiable to a species. Out of a total of 29 remains, three individuals were counted on lower cheek teeth. A total of four bones of large bovid, probably bison, was also recovered from the I11 site.
In general, reindeer and bison are characterized at both sites by low numbers of identifiable remains, but relatively high numbers of individuals, whereas horse is characterized by high numbers of remains and high numbers of individuals.

Skeletal representation

All skeletal parts of horse are present at the sector P16 site, even if some elements are only represented by one bone or one individual. The large number of skeletal parts, high numbers of individuals recorded on many skeletal parts and approximately equal amounts of bones from the left and from the right sides of the body indicate that intact carcasses of horses were deposited at the site or close to it. The presence of numerous less dense post-cranial bones among the horse remains at sector P16 indicates that the effects of density-mediated bone destruction on this assemblage were minimal. The extremely low numbers of ribs and some axial elements are certainly related to some extent to the fragility of these elements, but not entirely. The possibility that the differential preservation of parts of the back of the horse, as well as variations between ratings for leg bones (humerus, radius, femur and tibia) and their skeletal neighbours (scapula, pelvis and metapodials), could reflect transportation of these skeletal parts away from the site by humans, for example, cannot be excluded.
The frequencies of portions of bones such as the scapula, humerus, pelvis and femur, show positive correlations with intrabone variations in density recorded for these elements in other large-medium sized ungulates. Negative correlations were observed for the shafts and ends of radii, tibiae, metacarpals and metatarsals. The low counts for the shafts of these bones may be related to the initial fracture of these elements by humans, resulting in a reduction or loss of bone prior to post-depositional destruction. Low numbers of some portions of the mandible, including the robust mandible symphysis, and the differential preservation observed between anterior and posterior mandibulary cheek teeth may have resulted from humans smashing horse jaws into smaller pieces in order to obtain marrow. Some carcass portions of horse were recovered in anatomical connection.
On the whole, horse skeletal part representation from the sector I11 site is comparable to that observed at the P16 site. The horse remains are well-preserved and had hardly been affected by differential post-depositional destruction. All parts of the skeleton are represented except the caudal vertebrae and second metatarsals. High numbers of individuals were recorded on high-utility and on low-utility parts of the carcasses, and on robust portions of the bones.
In comparison to horse, remains of reindeer and bison were rare at both sites and, considering the relatively high minimum numbers of individuals of reindeer and bison, underrepresented. At sector P16, reindeer and bison have skeletal representations which are very similar to each other, which is unusual considering that we are dealing here with two species of very different body-size. The presence of elements from the head, some first cervical vertebrae, pelves and portions of limb and foot bones are characteristic for both species, as are the absence or extremely low numbers of other axial elements. There are no apparent differences between counts of individuals assessed on high-utility and on low-utility elements. As expected, high-density portions of elements are better preserved than low density ones. However, skeletal representation alone gives little indication as to whether these elements represent the remains of intensively processed, whole carcasses of reindeer and bison hunted and killed close to the sector P16 site, or portions of carcasses of animals hunted elsewhere which had been transported back to the site.

Age structure, population demography and season of death

The age structure, or the approximate age of horses at death, was assessed on dental attrition. 232 deciduous and permanent cheek teeth were placed in age-classes according to their degree of attrition. The results showed that the bulk of the teeth (76%) are from animals that died in their prime, sexually reproductive years. Juvenile horses represented only 15% and old or senile animals 13% of the population from P16. Similar results were obtained from analyses of the attritional stages of horse incisors. An analysis of bone epiphyseal fusion stages showed that some horses could have been as young as nine months of age when they died.

Extremely low numbers of canine teeth were recovered from the site, probably reflecting a dominance of females among the horses that died here. The composition of the horse population, with a few juveniles and old animals, a dominance of adult horses in their reproductive years, the presence of young foals and pregnant females, and a dominance of females, suggests that mainly horses living in family groups died here. Stages in the development of bones from two horse foetuses indicate that two of the mares died between February and March, about $2^1/_2$ months before they were due to give birth. Cementum analyses of teeth from Magdalenian deposits (sector J10) indicate that horses died in spring/early summer, summer and winter. It was concluded that horses died at Solutré from spring to autumn with the greatest concentration of deaths during the summer months (fig. 48).

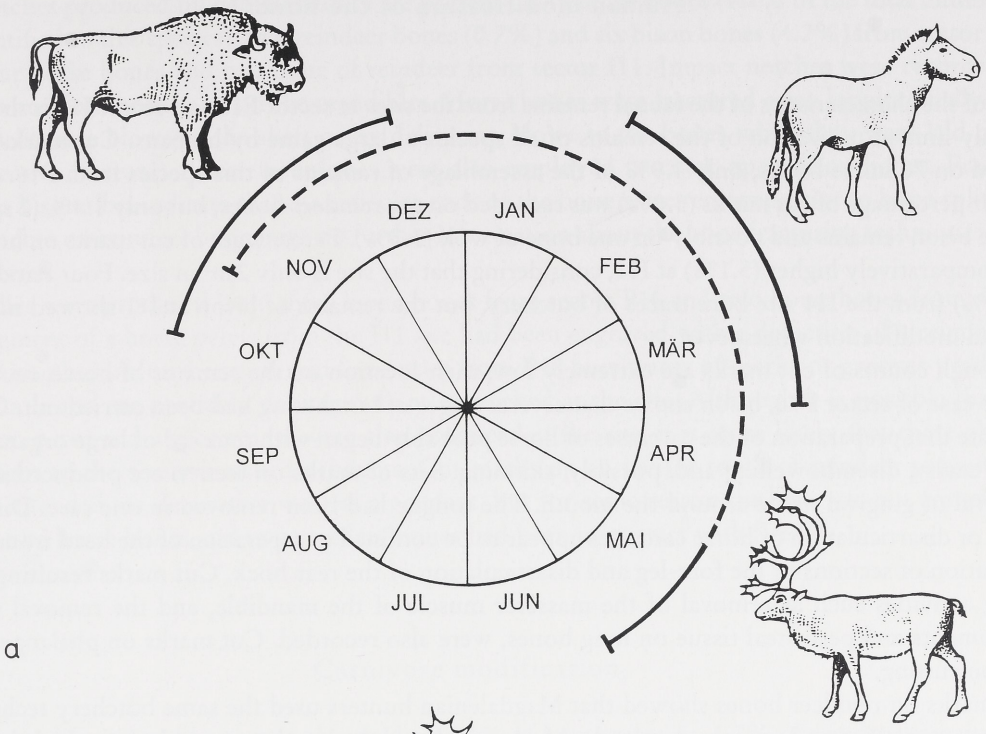
The age-structure of the horse population from sector I11 was also dominated by prime adult individuals. Juvenile horses represented 14% or 44% of the population, depending on whether the results of a conventional method of cheek tooth ageing using tooth heights and wear stages or the detailed analysis of ageing the teeth of individual animals were considered. Old or senile horses were extremely rare, representing only 2% of the population at the I11 site.

According to tooth eruption and wear patterns, young, adult and old individuals of reindeer were present at both sites, but a dominance of teeth from sub-adult and adult reindeer suggests that these animals were the preferred prey of the Magdalenian hunters.

Of particular interest for the demographic patterns and season of death of reindeer were seven pedicles from individuals which had just shed their antler and an antler frontlet from an individual which was just about to shed its antler, recovered at sector P16. The finds are from young reindeer of either sex which shed their antler in May. Reindeer are strongly social animals and maintain certain groupings known as bands. The eight juveniles at P16 were probably members of a juvenile band, common in the spring and autumn, which may have been killed together in a single hunting episode. If this was the case, the presence of pedicles and antlers from all eight carcasses suggests that these reindeer were killed at the site itself. According to the results of an analysis of reindeer tooth cementum, some reindeer also died during the winter months (December-March) and others in the spring (April-May) (fig. 48).

By using a combination of tooth eruption and wear patterns, stages of epiphyseal fusion and sexual dimorphism, the minimum number of individuals of bison at the sector P16 site could be increased from five to seven. The bison population at P16 consisted of a single adult male, two adult females, a subadult female, two juveniles, one of which was a female, and a calf of unknown sex. If these animals died during a single incidence, then the age and sex structure of the bison »herd« from P16 with its dominance of females, presence of a calf and juveniles/subadults is comparable to that observed in cow-calf groups. The time of death established for the calf and for the juveniles indicates that these young bison could have died together during a single hunting episode in autumn/winter (fig. 48). Only the remains of a single adult bovid were recovered from the I11 site.

Fig. 48 a The season of death of horse, reindeer and bison established during the current analysis. – b Compilation of a and extended by the results of incremental analyses of horse and reindeer teeth produced during earlier analyses of the faunas. Incremental analysis of horse teeth undertaken by M. Beasley (published in Olsen 1989) and incremental analysis of reindeer teeth undertaken by B. Gordon (1988). →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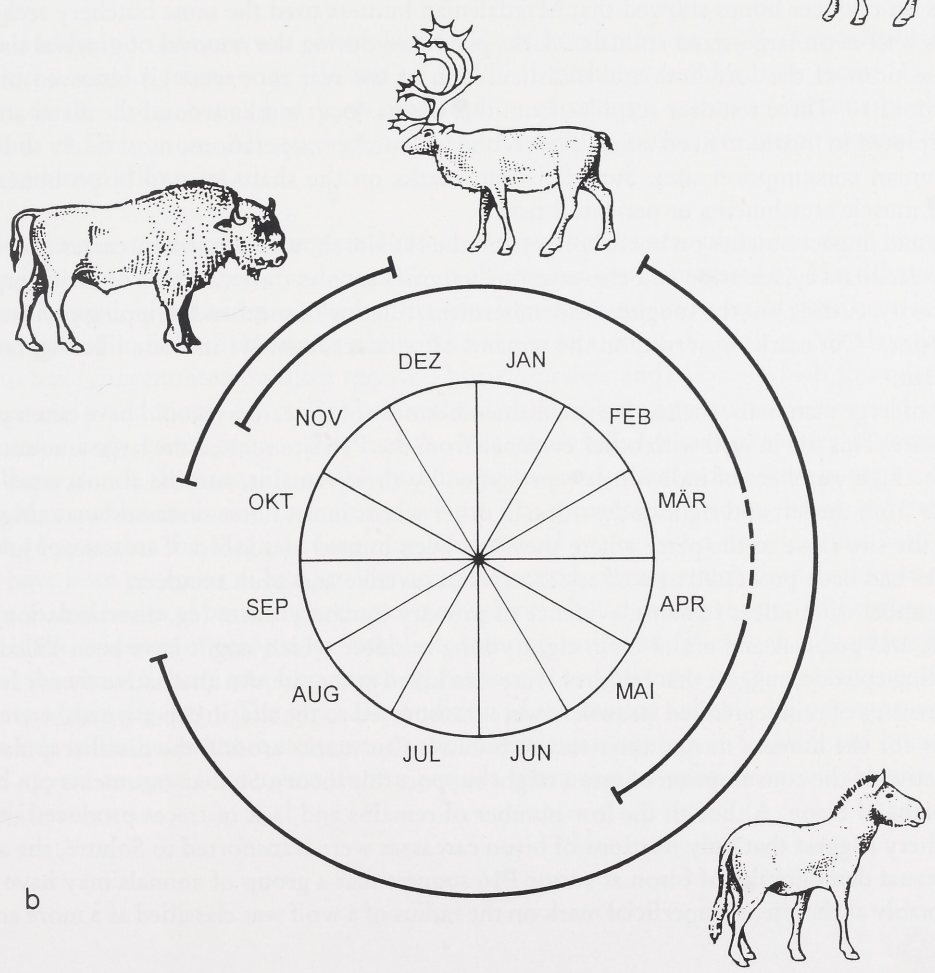
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Human modification of the bones

One of the characteristics of the faunal remains from the sites in sector P16 and sector I11 is the evidence of only limited utilization of the remains of all species of large game by humans. Cut marks were observed on 70 horse bones, only 1.9% of the assemblage of remains of this species from P16. A slightly higher percentage of cut marks (3.6%) was recorded on ten reindeer bones, but only 1.4% (2 specimens) of the bison remains and possibly on one bone of wolf (3.3%). Percentages of cut marks on horse bones are comparatively higher (5.1%) at I11, considering that the site is only 2 m^2 in size. Four reindeer bones (13.7%) from the I11 site bore traces of butchery, but the remains of bison at I11 showed no traces of human modification whatsoever.

Although counts of cut marks are extremely low, their location on the remains of horse, reindeer and, in the case of sector P16, bison shows that several stages of butchering had been carried out. Cut marks indicate that preparation of the carcasses of horse probably began with removal of large organs from the chest cavity, disembowelling and, possibly, skinning. Sets of marks on teeth were produced during the removal of gingival tissue around the mouth. The tongue had been removed in one case. Dismemberment or disarticulation of horse carcasses appear to be confined to separation of the head from the neck, separation of sections of the fore-leg and disarticulation of the rear hock. Cut marks resulting from filleting activities such as removal of the masseter muscle of the mandible, and the removal of muscle attachments and periosteal tissue on long bones, were also recorded. Cut marks on phalanges attest to tendon cutting.

Cut marks on reindeer bones showed that Magdalenian hunters used the same butchery techniques on medium as well as on large-sized animals. Marks produced during the removal of gingival tissue, separation of sections of the fore limb and disarticulation of the rear foot were all observed on reindeer remains from P16. Three reindeer scapulae from this site have cut marks around the distal articulation, often interpreted in medium-sized animals as secondary butchery operations, most likely to have taken place at human consumption sites. Superficial cut marks on the shafts of two bison bones attest to removal of muscle attachments or periosteal tissue.

Cut marks and impact notches on horse bones from the I11 site show that horse carcasses may have been hung up to facilitate evisceration and also attest to activities such as the extraction of major organs from the chest cavity, cutting out the tongue, dismemberment, filleting of meat and stripping periosteal tissues from the bones. Cut marks observed on the remains of reindeer from I11 indicate filleting, but not dismemberment.

In the case of large mammals, such as horses, dismemberment of the carcass would have taken place close to the kill-site. This fits in well with other evidence from the P16 site such as the large amounts of horse remains, the high numbers of individuals represented by these remains, and the almost equal numbers of elements from the left and right body-sides: in other words intact horse carcasses were originally deposited at the site close to the place where they had been hunted and killed. Carcasses of juvenile and adult horses had been processed as well as carcasses of juvenile and adult reindeer.

The low number of reindeer remains, evidence of primary butchery traces (eg. disarticulation) on reindeer bones, and pedicles and antler from eight young reindeer which might have been killed during a single hunting episode, suggest that reindeer were also killed at the site. An alternative theory is that portions of carcasses of reindeer killed elsewhere were transported to the site; in other words, were intended as »snacks« for the hunters during their stay at Solutré. Cut marks around the distal scapulae of reindeer, indicative of the consumption of meat, might support this theory. Similar arguments can be applied to the remains of bison. Although the low number of remains and lack of traces produced during primary butchery suggest that only portions of bison carcasses were transported to Solutré, the age-structure and sexual demography of bison at sector P16 suggest that a group of animals may have been killed, presumably at the site. A superficial mark on the radius of a wolf was classified as a more ambiguous cut mark.

Impact notches produced by hammerstones are present on 44 horse bones (1.2% of the total number of bones identified to this species), two reindeer bones (0.7%) and six bison bones (4.2%) from sector P16, and on four horse bones and one bone of reindeer from sector I11. Impact notches were recorded on horse limb and foot bones and on the mandibles. Horse bones were fractured open longitudinally by a series of deliberate blows to the shaft or by delivering blows to the bones while they were laid on an anvil (reflective fracture). These techniques were also employed to crack open bison bones. Fracture planes on a bison tibia indicate that the articular ends of the bone were removed prior to bone splitting. Impact notches on reindeer bones give no further information about the bone fracturing techniques used on this species.
Bone needles were produced from three horse bones from sector P16 and two horse bones from sector I11. A fragment of a horse pelvis from the I11 site had been engraved with a depiction of a reindeer. A very small number of fragments of reindeer antler from P16 bear traces of marks or grooves produced by stone tools and are probably debitage of antler worked at the site. Although it is possible that the antler bâton percé and antler points were also produced at the site, it is more likely that these objects were brought to the site as finished products. Cut marks on an incisor tooth of reindeer suggest this tooth was intended for decorative wear as a pendant, but for some reason the task was not completed. A total of two horse bones and two reindeer bones had been in contact with fire.

Carnivore modification

Carnivore modification of bone was observed on 7.3% of horse remains, 6.7% of reindeer remains and 14.0% of bison remains from sector P16 and on 16.4% of the horse remains from sector I11. Practically all parts of the horse bones had been modified by carnivores, which preferentially chewed the articular ends of limb bones. All stages of carcass utilization by carnivores were recorded, from light utilisation to heavy utilization.

Cut marks, hammerstone-induced impact notches and worked bones, antler and teeth show that not only horse, but also reindeer, bison and, possibly, wolf remains were processed by Magdalenian hunters. Horses were hunted, killed and processed at the site. Reindeer and bison could have been killed at the site, or transported to Solutré as carcass parts. With the exception of the wolves, Magdalenian hunters appeared to have concentrated on three species – horse, reindeer and bison – which all undertake some form of seasonal wanderings. The valley below the rock of Solutré appears to have served as a regular migration route between the Saône valley and the Mâconnais hills for several species of game.
Based on the evidence of seasonality established during this analysis, reindeer were hunted between December to May and bison during autumn and winter. The presence of 3 young bison and the season of their death suggest that the Magdalenians may have hunted young bison on a seasonal basis. Reindeer appear to have been procured over a broader seasonal period, during which time distinct social groups were taken. Foetal bones of horse show that two mares were killed during the period February to March (fig. 48a). If the evidence of seasonality established during earlier analyses is also considered, it would appear that the site at Solutré was frequented by humans at several times of the year during the Magdalenian phase of use (fig. 48b). The physical condition of the hunted animals did not appear to play an important role in the subsistence strategies of the Magdalenian hunters at Solutré, and horse, reindeer and bison appear to have been taken during periods when their condition varied substantially from poorest to best.

HORSE HUNTING TACTICS AT SOLUTRÉ

Turning now to the horse remains, the following list summarizes the main criteria established during the current analysis which characterize the assemblage of horse bones from the kill and butchery site of Solutré during the Magdalenian period. In general, the results of this analysis confirm those of previous analyses of the Magdalenian faunas from Solutré (Berke 1989; Levine 1979, 1983 and Olsen 1989, 1995):

mainly horses living in family groups were hunted
large numbers of individuals were killed
mainly adults, but also some juveniles, were killed and butchered
low numbers of cut-marked bones
low numbers of bones broken open to obtain marrow
large number of bones left at the site, sometimes in anatomical connection
extremely low numbers of bones used as a raw material for a bone industry
extremely low numbers of charred bones
relatively high percentages of carnivore gnawed bones

The most unusual aspect of this site is the discrepancy between the large number of horses that apparently died here, and the low number of horse remains bearing traces of having been butchered by the hunters. The low numbers of cut and other butchery marks are, in my opinion, not wholly related to bone preservation. Could the lack of cut marks be due to the expertise of Magdalenian butchers whose methods of carcass processing left few traces behind? Artistic depictions show that the Magdalenians were not only fully conversant with the appearance of living horses but also with horse anatomy, as can be seen in the figure of a de-fleshed head of a horse from the Magdalenien site of Mas d'Azil in France (Piette 1907). Olsen (1989 p. 309), however, argued that it did not seem reasonable to explain low numbers of cut marks on horse bones by either »extraordinarily careful butchering« or »an ignorance of butchering methods« since butchery marks were present on the bones of other species at Solutré.
Is the minimal processing of horse carcasses linked to the way in which horses were hunted? In her paper Olsen (1989) considered five basic hunting hypotheses to explain how the site at Solutré formed. The first hypothesis returned to the »jump« theory where horses were chased up the slope of the rock and either run off the western end of the cuesta or off the southern edge of the rock directly above the site. In the second hypothesis, the possibility that the large amounts of horse bones accumulated after a series of repeated natural catastrophes was considered. In this hypothesis, the lithic artefacts and other cultural remains were either unrelated to the faunal remains or were deposited as humans scavenged from carcasses of horses at the site. That Solutré represented a base camp to which horse remains were transported from a kill-site at another location was the third hypothesis, and the killing of small numbers or single horses as they wandered close to the site was proposed as hypothesis four. In hypothesis five, horses were killed as they passed through the valley below Solutré rock in bands of around 6-12 individuals. These bands were intercepted by the hunters in the valley and driven up the slope towards the southern face of the rock, where they were corralled and killed. In a paper published in 1995, Olsen described hunters at Solutré utilizing a natural indentation in the southern face of the rock as a corral by enclosing the entrance with simple structures in a manner similar to that apparently used at bison kill sites in North America such as Wardell (Frison 1973), Boarding School (Kehoe 1967), Gull Lake (Kehoe 1973) and Garnsey (Speth and Parry 1978). Olsen (1989) concluded that all the indices – vast numbers of horses, articulated units of horse bones, scarcity of butchery marks, low numbers of spiral fractures (as a possible result of marrow extraction) and lack of evidence of transportation of meat-bearing bones away from the site (see page 139) – pointed to the killing of many horses in a single episode and an underexploitation of horse carcasses. She concluded that the best explanation for this »long tradition of wastage« (ibid. p. 324) was the relative ease associated with driving horses into a corral and then killing them, as proposed in hunting hypothesis five: a hypothesis which is also in keeping with wild horse behaviour, and is supported by the topography of

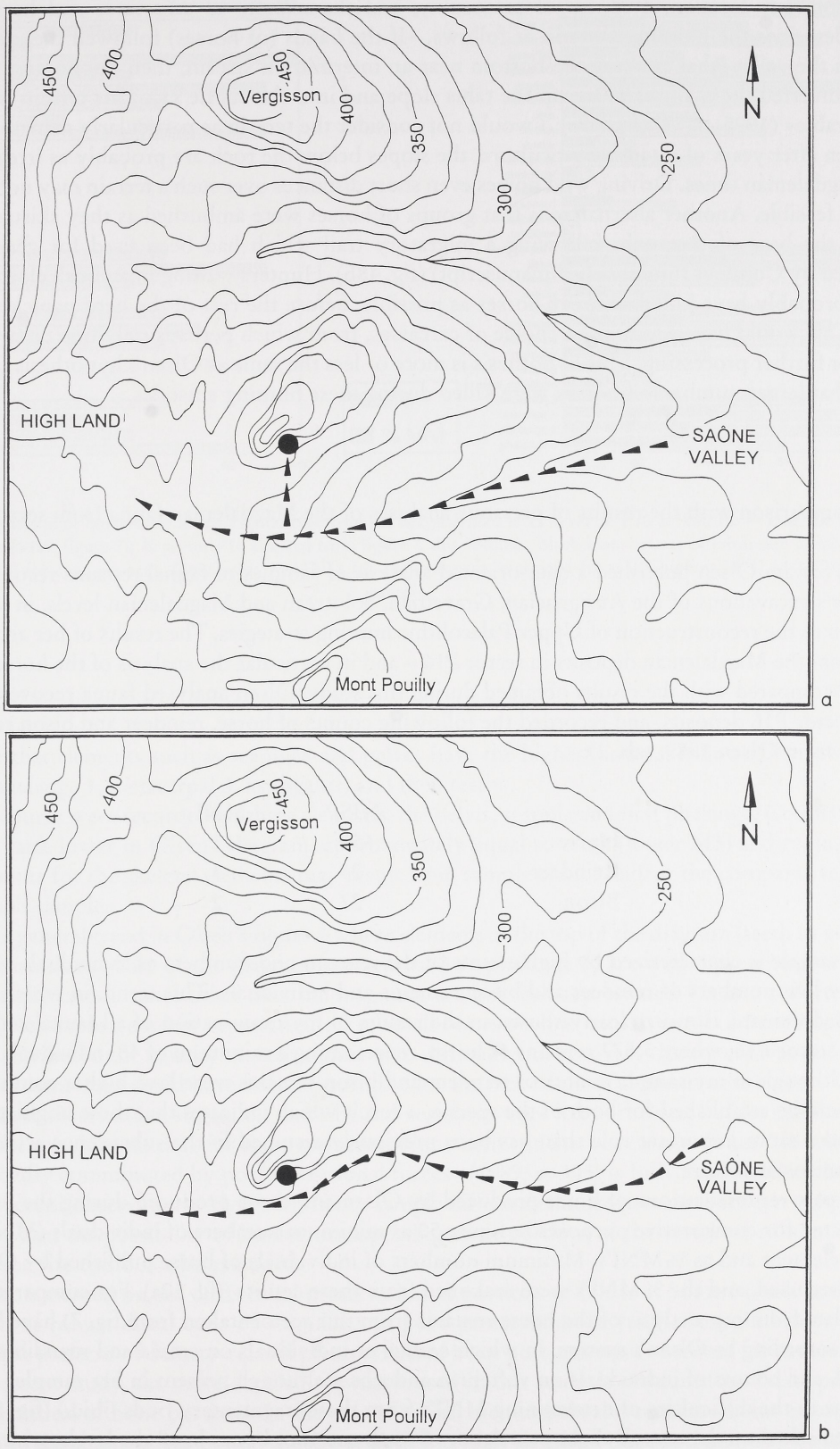


Fig. 49 Magdalenian horse hunting tactics a) Olsen's (1989, fig. 2) suggestion where horses were intercepted in the valley below Solutré rock, driven up to the bottom of the southern cliff face, corralled and killed there. b) Combier's proposal (unpublished manuscript, fig. 10) where horses were ambushed as they followed a migratory trail around the base of Solutré rock.

the region, site location, evidence of seasonality, and the scarcity of structures and hearths (ibid.). Olsen describes the hunting scenario as follows. »If the bands (of horses) followed the easiest course through the valley, that is along the bottom near an intermittant stream, then the hunters could have simply diverted them about 200 m up the talus slope and into the cul de sac. This terrain is easily manoeuverable« (1995, p. 73) (fig. 49a). I would not consider the terrain as particularly maneuverable. Today, even after years of intensive viticulture, the slopes below the rock are probably as irregular as during Magdalenian times. Driving wild horses even short distances over such a terrain may not always have been feasible. Another alternative is that groups of horses were ambushed as they skirted single file around the base of the rock, following a migratory trail which had been used for generations, as suggested by Combier (unpublished manuscript) (fig. 48b). Hunters waiting in ambush close to the trail would probably have killed as many horses as possible, before the rest of the herd panicked and took flight. This would have produced a choice of carcasses, from which perhaps only one or two were selected for further processing. This hypothesis is more or less the same as Olsen's hypothesis four, but assumes that larger numbers of horses were killed during these hunting episodes.

Comparison with the results of previous analyses of the Magdalenian fauna from sector P16

In 1989, Sandra Olsen published a data-oriented analysis of samples of faunal remains recovered during Combier's excavations of the Aurignacian, Gravettian, Solutrean and Magdalenian levels, in a theoretical approach to the reconstruction of Upper Palaeolithic hunting strategies. The results of her analysis of the fauna from the Magdalenian deposits in sector P16 – and in particular the analysis of the horse remains –, are now compared with the results obtained during this study. Olsen analysed fauna recovered in 12 m^2 of the sector P16 deposits, and recorded the following counts of horse, reindeer and bison remains (data taken from Olsen 1989, tab. 2):

	NISP	MNI
Horse	658	11
Reindeer	25	3
Bison	27	2

Olsen's sample is characterized by high counts of the remains and numbers of individuals of horse and relatively low numbers of reindeer and bison remains and individuals. This trend, in which remains of horse predominate, is more clearly shown in the results of my examination of all faunal remains excavated at sector P16, where 3,577 remains of horse, representing a minimum of 45 individuals were identified. Although in my sample counts of reindeer and bison remains were low, higher counts of individuals could be established for both of the species, a result which indicates that these ungulates may have played a more important role than has been previously assumed in the subsistence activities of the Magdalenians at Solutré.

Skeletal part representations of horse produced by Olsen and those produced during the recent study are depicted for comparative purposes in figure 50 as minimum numbers of individuals (MNI) for each skeletal element and as %MNI's. Minimum numbers of individuals of horse published by Olsen (1989, fig. 8) were used, and the %MNI's were reckoned from these counts (fig. 50a). For comparative purposes the data from my analysis of the horse remains from this sector (taken from fig. 7) have been re-organised according to Olsen's system, in which counts of individuals on crania and mandibles were not depicted, and counts of individuals on vertebrae and ribs – although present in her samples – were not given due to the difficulties of determining MNI's from these fragmentary finds (ibid.) (fig. 50b).

Olsen remarked on the overall slight prevalence of teeth and foot bones in all the levels, which she attributed mainly to their durability when compared to other skeletal elements. The new analysis has, how-

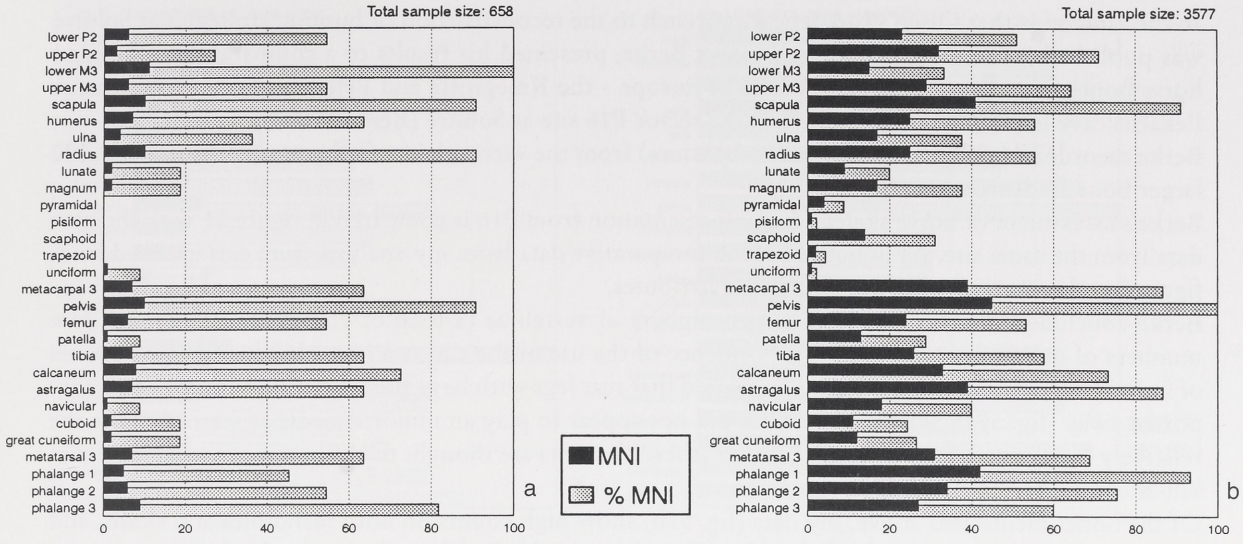


Fig. 50 Comparison of horse skeletal representations from the Magdalenian level in sector P16 at Solutré. – a: sector P16 adapted from Olsen (1989, figure 8); b: sector P16 adapted from figure 7, this volume. Black bars: counts of minimum numbers of individuals (MNI) for each element. Grey bars: % MNI's for each element, reckoned from the highest MNI (= 100%) of each sample.

ever, shown that elements such as scapulae and pelves have the highest counts, followed by lower limb bones (eg. phalange 1, metacarpal 3, astragalus) and then teeth.

High MNI counts were recorded on three elements, the pelvis, scapula and first phalange. Counts for these elements rank lower in Olsen's diagram, approximately equal to teeth (lower M3) and radius. Differences in counts for the skeletal elements may result from sample choice and/or the comparatively small size of Olsen's sample.

Otherwise, a general trend in Olsen's figure – where elements at the top of the diagram (teeth to magnum) and those towards the base of the diagram (metacarpal 3 to phalange 3) are well-represented, and small bones, especially carpal bones other than the magnum, are less well-represented – is also reflected in the new data. Olsen reported a low representation of small bones such as carpals in all of her samples from Solutré and attributed the paucity of such elements to difficulties of recovery during excavation. I would consider that carnivores could have been responsible for the lack of these elements at the site.

Olsen's general observations suggested that ribs and vertebrae were left at the site, but for the reasons given above she provides no data for these elements. Her statement that ». . . these bones (ribs and vertebrae) were badly comminuted by postdepositional forces« (1989, p. 305) is fully supported in the case of ribs, by the recent observations. However, in my sample differences in frequencies between types of vertebrae meant that the possibility of hunters transporting some portions of the vertebral column of horse away from the site could not be excluded.

Olsen also commented on the differential preservation of portions of bones at Solutré (such as the good preservation of robust distal ends of scapulae and poor preservation of fragile scapula blades) and although similar patterns of density-related preservation of bone portions were observed for some elements during the recent study, the more detailed approach used in this analysis produced new data pertaining to the preservation of bone portions. In the case of tibias, metacarpals and metatarsals for example, low frequencies of the shafts of the bones, usually regarded as high-density bone portions, may be related to the initial fracture of these bones by the hunters to extract marrow.

In the same year that Olsen's theoretical approach to the reconstruction of hunting strategies at Solutré was published, a German researcher, Hubert Berke, presented his results of a comparative analysis of horse bones from four Magdalenian sites in Europe - the Kniegrotte and Petersfels caves in Germany, Pekárna cave in the Czech Republic and the sector P16 site at Solutré (Berke 1989).
Berke recorded 16,500 bone fragments (»Splitter«) from the »secondaire« find category as well as 3,190 larger bone finds from sector P16.
Berke's assessment of horse skeletal part representation from P16 is compared in figure 51 with the new data from the same site. As in figure 50, the comparative data from my analysis were extrapolated from figure 7 and re-organised to match Berke's attributes.
Berke concluded that the relatively large numbers of vertebrae (a total of 200 finds), along with low numbers of mandibles and skulls were evidence of the use of the site as a horse kill locale. Low counts of individuals on femurs and patellae suggested that rear legs with large portions of meat had been transported away (fig. 51a). Skinning activities did not appear to play an important role at sector P16, as the relatively high counts for phalanges showed (these elements are thought to have been carried away from kill-sites attached to the skins).
Of the bones mentioned above, my data (fig. 51b) show high counts on both mandibles and skulls, and the count for the femur is only slightly less than those established for other major leg bones at the site (tibia, humerus and radio-ulna). Only the relatively low count for the patella is comparable to Berke's data, and probably reflects the lower survival chances of this porous bone, rather than transportation from the site as part of the economic decisions of the Magdalenian hunters. Relatively high numbers of individuals are depicted for the phalanges in both samples but in my diagram, the counts are inverse to those produced on these elements by Berke.
The differences in data depicted in figure 51 are probably not due to sample size. Assuming that the individual counts depicted in Berke's diagram are based on the larger bone finds, then there is little difference between the 3,190 finds that Berke recorded and the 3,477 finds recorded in the recent analysis. This fact makes the large numbers of individuals counted in my sample – generally twice the numbers that Berke published for each element – somewhat surprising.

Olsen noted that despite heavy root-etching, a few cutmarks could be observed on the surfaces of three horse bones from sector P16 attesting to dismemberment and tendon removal, and on one mandible of reindeer. Although the analysis of the total number of faunal remains from sector P16, produced a larger number of bones with butchery traces, I would agree with Olsen's conclusion that the relative scarcity of butchery marks (cut marks), particularly on the equid remains, cannot be explained by poor bone preservation alone. In my opinion, this phenomena is probably related to the methods used to kill the horses which produced a glut of carcasses from which perhaps only one or two were chosen for further processing.
My observations show that not only dismemberment and tendon removal took place, but also filleting, the removal of gingival and periosteal tissues and, possibly, skinning.
Berke (1989) observed butchery marks (cut marks and impact notches) on 113 or 3.5% of the horse bones from sector P16 that he analysed. I observed a total of 114 horse bones with cut marks and impact notches, and this number is comparable to his total. The locations of butchery marks depicted by Berke (1989, fig. 5) are also comparable to those that I recorded. Berke also noted evidence of the use of an anvil to support bones during fracturation (reflective percussion), and several horse bones found during the recent analysis had been fractured using this method. Olsen recorded spiral fractures on a total of 16 horse bones from her Solutrean and Magdalenian samples, but she did not describe bones with hammerstone-induced impact notches in detail.
Olsen interpreted bone artifact debitage, needles ornaments and mobiliary art at Solutré as evidence that hunters conducted a variety of activities at the site other than hunting and butchering. For Berke, the low number of bone artifacts at Solutré is typical of kill-sites, and he suggests that the hunters were probably removing large amounts of raw material – metatarsals attached to the rear legs – away from the

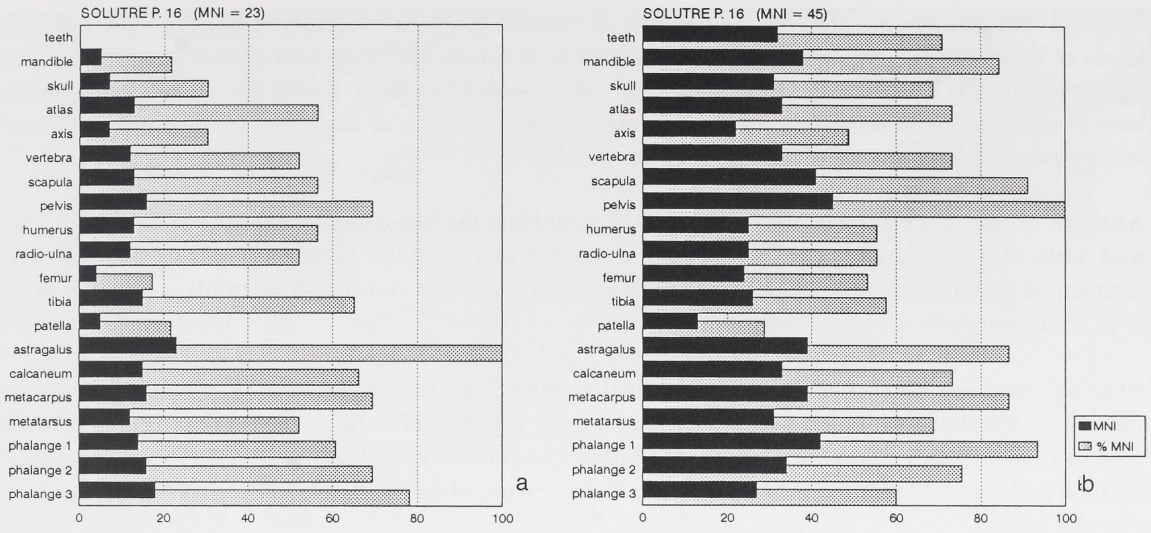


Fig. 51 Comparison of horse skeletal representation produced during two separate analyses of faunal remains from sector P16 at Solutré. – a: results of Berke's analysis of a sample of horse bone from sector P16. – b: results from the current analysis adapted from figure 7. Black bars: counts of minimum numbers of individuals (MNI) for each element. Grey bars: % MNI's for each element, reckoned from the highest MNI of each sample.

site. Needle-cores at sectors P16 and I11 do indicate the manufacture of these objects at the site and the engraving of a reindeer on the iliac bone of the pelvis of a horse suggests that the hunters did have time to indulge in such pastimes between their hunting and butchering activities. Other finds, such as the antler bâton-percé, may have been brought to the site as finished products.

Levine (1979, 1983) examined horse teeth from Solutré including a sample from the Magdalenian level in sector P16. Her sample of 364 ageable teeth from P16 was larger than the one sampled recently, but despite this similar results were produced from both studies. Levine also noted a rather low proportion of teeth from horses aged between 0-3 years. After adjustment to compensate for what she interpreted as the differential preservation of less sturdy deciduous teeth, percentages of teeth in her sample in the juvenile age-group (0-4 years) fluctuated between 10% and 6%, slightly lower than the percentage for this group in my sample. Teeth aged to twelve years, which are from horses at the beginning of their old age range, formed 3-4% of her sample; horses older than 12 years gradually diminished to less than 1%. Levine noted a rather high, but relatively unimportant representation of teeth from 3-4 year old horses, which is not present in my sample, and a proportional increase of teeth from 4-9 years (Levine 1979; 1983, fig. 4. 20).

As in my analysis, the highest percentages were recorded for teeth from prime adult horses. Teeth from horses aged to about nine years attained, after adjustment, percentages of up to 12% in Levine's analysis, but the extremely high percentages for horses dying between 6-10 years as depicted in my graph, are missing in Levine's. The differences in the results of the two analyses could be due to sampling. For example, only those cheek teeth which could be definitely identified to element and position in the jaw were included in my sample and of these the permanent teeth were aged using crown-heights; the less accurate wear-stages were only applied to the deciduous teeth. Levine also explains the low proportion of juveniles, the higher number of 3-4 year olds and the increasing proportion of 4-9 year olds in her sample, as resulting from a number of factors, including chance sampling bias. The fact that the same basic trends – low numbers of juvenile and old horses and a dominance of prime adult horses – appeared in the population structures produced by both studies, shows that sampling did not bias the different analyses too much.

Olsen (1989) also commented on the paucity of remains of juvenile teeth and bones in the different levels at Solutré and suggested that this might have been due to releasing young horses unharmed after killing the adults. Butchery traces observed on the remains of juvenile horses during the recent study have shown that these were killed and processed in the same way as adult horses, but that adult horses appeared to have been the preferred prey.

Analyses of the incremental bands of a sample of teeth from the Magdalenian deposits in sector J10, showed death of horses in spring/early summer, in summer and in winter (Olsen 1989). The stage of development of foetal bones of horse found during my analysis of the sector P16 assemblage suggests death of at least two mares around February to March.

Although previous analyses of samples of faunal remains from sector P16 have provided important insights into Magdalenian hunting tactics and butchering activities at Solutré, the results presented in this volume of an analysis of the total number of faunal remains recovered from this sector, provide a more detailed and accurate picture of the hunting and processing of horse, bison and reindeer at Solutré during this period.
The next step is to use this data as the basis for comparative analyses with faunas from other Magdalenian sites. In the following section, the data about horses collected during the analysis of the sector P16 finds will be compared with data from three other Magdalenian sites where the horse appears to have also played an important role in the subsistence activities of the site occupants.

A COMPARISON OF HORSE REMAINS FROM MAGDALENIAN SITES IN EUROPE

Faunas dating to the Magdalenian period which are dominated by horse, or where horse is the most common species in an otherwise diverse fauna have been described from a number of sites in Europe (fig. 52). Three sites, Grand Canton at Marolles in France (Bémilli 1994; Bridault and Bémilli 1999), Andernach-Martinsberg (Street 1993) in the Central Rhineland of Germany and Hauterive-Champréveyres in Switzerland (Morel and Müller 1997) have been recently analysed in detail. In the following section data from these sites are described and, finally, compared with the results of the analysis of horse remains from sector P16 at Solutré presented in this volume.

Grand Canton, Marolles (Seine et Marne, France)

The site of Grand Canton at Marolles with its horse dominated fauna, has modified the image that the Magdalenians in the Paris Basin were solely reindeer hunters (Bémilli 1994). Marolles is an open site located on an interfluve – a ridge or area of land dividing two river valleys – some three kilometres away from the confluence of the Seine and the Yonne rivers, only a few kilometres away from the major Magdalenian site at Pincevent. The site was discovered during motorway construction, and was investigated in a series of rescue excavations between 1990-91 (Alix et al. 1992; Alix et al. 1993; Rieu et al. 1990). The evidence recovered so far suggests repeated occupation of the site around 12,000 BP, during the Dryas II period. The Magdalenian industry is made up to 98% of flint from secondary deposits of alluvial origin. The total of 434 tools is dominated by burins, followed by scrapers, backed blades, points and becs. The remains of nine hearths were also revealed.
First analyses of the faunal remains were carried out by Averbouh for site sector 1 (in Alix et al. 1993) and Bridault (1993) for sector 2 of the site. The following information is taken mainly from Bémilli's

Fig. 52 Map depicting Magdalenian sites described in the text. – 1 Solutré. – 2 Grand Canton, Marolles. – 3 Andernach-Martinsberg. – 4 Hauterive-Champréveyres.

(1994) analysis of the fauna from sector 2, sample A, details of which are also published (Bridault and Bémilli 1999). The fauna from this sector of the site is dominated by horse. From a NISP of 3,269 remains of horse a MNI of 74 has been reckoned, but the total number of horse individuals for the whole site could be as high as 150. Low quantities of reindeer (MNI 4), bovid (MNI 1), canid, probably wolf (MNI 1) and mammoth (MNI 1) have also been recovered.

Practically all parts of the horse skeleton are present at the site, but in varying proportions. Tibiae, first phalanges, tarsals and calcanei have high counts, followed by low counts for atlas vertebrae, cervical and other vertebrae, ribs and small bones (fig. 53). Bémilli states that these patterns could have been produced by either human selection of certain body parts during butchery or the differential preservation of bone. Due to the lack of bone density data for horse remains during the early 1990's, she refrained from a definite interpretation of these patterns of skeletal representation.

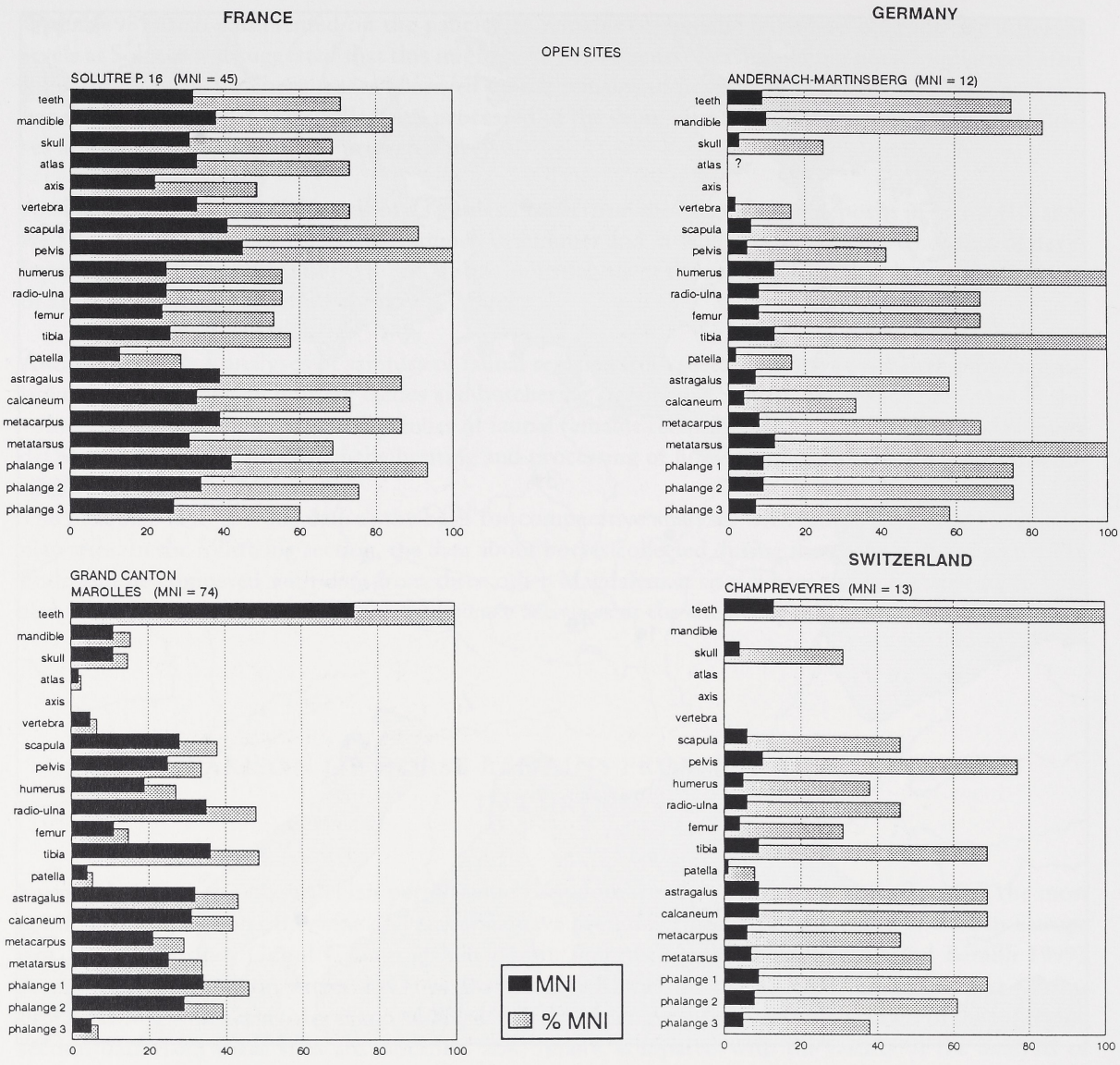


Fig. 53 Comparison of horse skeletal part representations from selected Magdalenian sites in Europe. Data for Solutré P16 taken from figure 7, this volume; Grand Canton, Marolles after Bémilli 1994, fig. 15, column NMI f; Champréveyres after Morel and Müller 1997, fig. 20, column NMI; Andernach-Martinsberg after Street 1993, fig. 60 (highest MNI).

The age-structure of the horse population has an important peak at about 6-10 years, in other words is characterized mainly by »young adults« (fig. 54), and Bémilli concluded that if hunters had been taking family groups, larger numbers of individuals in the age classes »young« and »sub adult« would be expected than this age-profile shows. There were probably less than 4 males in the population (based on numbers of canines). There was no information about the season of death of the horses.

Cut-marks were not observed on the poorly-preserved bone surfaces, but many bones had been marrow-fractured. Bémilli concluded that horses were probably hunted in small groups close to the site, to which practically all parts of the carcass were transported.

Andernach-Martinsberg (Central Rhineland, Germany)

Along with the site of Gönnersdorf, the site at Andernach-Martinsberg represents a major open settlement dating to the Magdalenian period in the Neuwied Basin of Germany. Located close to the northern entrance of the Neuwied Basin, the Andernach-Martinsberg site was discovered as early as 1883 (Schaaffhausen 1888), but systematically excavated later between 1979-1983 (Bosinski and Hahn 1972; Veil 1982). A series of six AMS dates from Andernach and three AMS dates from Gönnersdorf date the Magdalenian at these two sites to 12,982 ± 58 BP (mean) (13,365 ± 155 cal BC) and 12,809 ± 57 BP (mean) (13,195 ± 155 cal BC) respectively (Street, Baales and Jöris 1999). Thus the Magdalenian settlement of both sites definitely took place before the beginning of the Late Glacial Interstadial Complex, and not at the end of the Bölling Interstadial, as suggested by previous researchers (Bolus et al. 1988).

Four major concentrations of finds were uncovered at Andernach. Two of the concentrations are interpreted as stable, paved dwelling structures and contained slabs of slate, quartz and quartzite, along with animal bones, lithic, bone, ivory and antler artefacts, objects of personal adornment, and many objects of art, including engraved schist plaques (Street 1997). A third concentration of finds was located around a large fissure running through the site, which was probably open at the time of occupation. The fourth concentration was excavated more recently (Bergmann 1999; Holzkämper 1999).

The lithic assemblage contains all forms typical of Upper Magdalenian inventories. Different raw material groups are associated with different concentrations (e.g.: Tertiary quartzite in concentrations I and II), as are dominances of certain tool forms (e.g.: scrapers outnumber burins in concentrations I and III).

The site has produced a rich faunal assemblage including numerous remains of larger and smaller mammals, birds and fish. The following description is based on the results of an analysis of the Andernach fauna undertaken by Street (1993; 1997).

Horse dominates the hunted fauna in terms of its importance in the subsistence strategies of the Magdalenians and a total of 2,201 finds at Andernach could be identified as horse. A minimum of twelve individuals of horses are represented. Street has postulated that the underrepresentation of horse vertebrae at Andernach could be due to human destruction of these elements, since all identified fragments of these elements appear to have been pulverised, but that equally low counts for proximal ribs may indicate that proximal ribs and vertebrae were left at the kill-site. Horse skeletal part representation is otherwise characterized by the presence of practically all body parts in varying proportions, and by relatively high percentages of mandibles, humeri, tibiae and metatarsals (fig. 53).

At Andernach the horse age-profile is characterized by low numbers of juveniles and senile horses. There is a high peak in the number of animals aged to between 6-10 years, a smaller peak at 11-15 years, and a notable underrepresentation of 4-6 year olds (Street pers. comm. 1999).

The stage of development of horse foetal bones indicates death of some mares during winter.

Street (1993) describes the evidence of horse carcass processing at Andernach in detail in his dissertation, and the following is a brief summary of these descriptions. Poor bone surface preservation at Andernach meant that only a few cut-marks were preserved. Even so, cut mark evidence combined with the location of impact notches and patterns of the fracture of horse bones shows horse butchery at Andernach was very standardized. Cut marks were found on maxillary cheek teeth, possibly resulting from cutting through the lips or cutting too deeply during skinning. Cut marks on the most proximal part of the humerus, and on the distal humerus and proximal radius attest to the disarticulation of the scapula from the humerus and the humerus from the radius at the joints. Femur and tibia were disarticulated at the knee joint.

No cut marks were preserved on the metapodials, but phalanges – which due to their small size were often incorporated into pits and thus better preserved – did bear traces of cutting. These marks have been interpreted as either resulting from cutting the bones out of the soft tissues of the foot, or disarticulating the phalanges from one another, or cutting sinews and tendons from the phalanges. A cutmark across a proximal sesamoid was produced when the first phalange was removed from the metapodium. Cut marks on the third phalanges may have been produced when horn sheaths were removed. Cut marks produced during filleting activies were only observed on femur shafts.

Impact notches and/or patterns of bone fracture show intensive reduction of horse bone during the further stages of butchery. The ascending ramus of the mandible was fractured off and the lower border opened by blows to both the lateral and medial faces. Humerus and radio-cubitus show repetitive fracture patterns: very obvious is the almost complete absence of the proximal and distal humeri, whereby larger numbers of epiphyses from the radii had survived. The humerus was opened by blows to the lateral and caudal faces. Blows were often placed laterally to remove the distal epiphysis and caudally to remove the proximal epiphysis. Blows to the flat volar face were used more often than blows to the convex dorsal face to open the radius shaft. Several blows along the shaft were often employed to split the radius open.
Fracture patterns on the pelvis show that the ilium and the ischium were regularly removed by bone-smashing. Femur and tibia epiphyses are, on the whole, rare, but large numbers of distal tibia fragments from the right body-side as opposed to only two fragments from the left body-side, are an exception to this. Whether this preservation reflects differentiated treatment of the carcass by body-side is unclear. The tibia was more commonly fractured by blows to the flatter dorsal face; the femur shows a less standardized pattern of fracturation, probably due to its round cross-section.
Metapodials were fractured by blows to the dorsal and volar/plantar faces. These blows were often reflected causing the bone to split through the proximal end, leaving a detached distal end which automatically broke off. This method of fracturation also provides a suitable bone fragment (the distal end and part of the shaft) for use as a needle-core or a retouching tool. The use of an anvil as a support is attested by opposed, reflected impact notches on radius, tibia and metapodial shafts.
Fracture of first phalanges seems to have been standard practice at this site, and the number of intact first phalanges is very small.

Hauterive-Champréveyres (western Switzerland)

The late Magdalenian open site of Hauterive-Champréveyres is located on the northwestern edge of Lake Neuchâtel at the foot of the Jura mountains. Excavations between 1984 and 1986 were undertaken in advance of motorway construction and a total of about 250 m^2 of this site have been investigated. The following description of the site and its fauna is taken from Morel and Müller (1997).
The main Magdalenian horizon has been radiocarbon dated (AMS) to about 13,000 BP. Situated at about 427 asl., the site was originally located near to a part of Lake Neuchâtel which at that time was separated from the rest of the lake by a gravel bar. The late Magdalenian site of Neuchâtel-Monruz lies only one kilometre away to the south-west. Refitting blades from these sites show that site occupation was contemporary, and the two localities may have formed part of a series of camps located at strategic points for hunting along the edge of the lake. Certainly, the absence of habitation structures, poor lithic assemblage (5500 flints > 1 cm), flat, infrequently-used hearths and the spatial distribution of the archaeological material suggest that the site was either occupied only once, or on several, brief occasions. The predominance of backed bladelets in the lithic inventory, and microwear traces produced during meat and hide processing, suggest that Champréveyres was also used as a camp where game was butchered during this occupation(s) (Morel and Müller 1997).
About 16,500 bone finds were recovered during excavation and a further 120,000 unidentifiable fragments were recovered during sieving. All of the faunal remains are highly fragmented due to marrow fracturing and subsequent post-depositional deformation of the archaeological horizon. In addition to this, most of the bones are poorly-preserved, as, for example, the dominance of teeth in the assemblage of horse remains clearly shows (fig. 53).
Morel and Müller identified twenty species including ten mammals, five birds and five fish. Horse is the most common species (MNI 13 and not more than 21), followed by arctic hare (MNI 20), marmot (MNI 16), reindeer (MNI 7), ibex (MNI 3), lynx (MNI 3), arctic fox (MNI 2), and ?bison (MNI 1).
Intact or only partially dismembered horse carcasses appear to have been brought to the site. There is no evidence that horse skeletal parts were transported away from the site. A total of 2,956 remains were

definitely identified to horse and a further 1,916 were attributed to this species based on their size. The assemblage of horse remains is dominated by a total of 2,235 teeth, a direct result of the poor state of bone preservation at this site. Mandibles are, with a total of 248 finds, relatively well represented, as are tibiae (167 finds), crania (106), metapodials (114) and first phalanges (101). Axial elements such as vertebrae are extremely underrepresented (192 finds). Ribs, with a total of 116 finds, appear to be relatively well-represented, but of these pieces, only 23 could be certainly identified to horse (Morel and Müller 1997, fig. 16: fig. 52 this report).

The age-structure of the Champréveyres horses is characterized by a very high peak of young horses, especially those aged between 2-3 years, absence of horses aged between 4 and 5 years, lower peak of adults between 6 and 10 years of age and absence of horses aged over 11 years and over (Morel and Müller 1977, fig. 45). This distinctive age-structure may be due to the more detailed way in which the ages were assessed. At Champréveyres it was possible to reconstruct the dentitions of individual horses and to age these individuals using incisor wear patterns described by Habermehl (1966), and/or cheek-tooth heights following Levine's method (1983) (the authors state that a conventional plotting of tooth crown-heights, without sorting to individuals, produced the adult-dominated age-profile so typical of horse-populations found at other Magdalenian sites). The age-structure appears to indicate selective hunting, particularly for young horses, on the part of the Magdalenian hunters (fig. 53). The age of some of the young horses shows that they probably died in spring and in autumn. Attempts to assess the sexual demography of the horses was not undertaken due to the difficulties associated with this type of analysis, but the presence of young foals does suggest that family groups were hunted some of the time.

A total of 485 or 10% of the horse bones bore traces of cut marks (Morel and Müller 1997, fig. 70). Although some wear traces on lithic artefacts were produced during skinning activities, cut marks indicating skinning were not observed on the bones. Only a small number of cut marks were located in places indicating disarticulation. The bulk of the cut marks was located on the shafts of long bones – especially scapula, humerus, radius, femur and tibia – on mandibles and, more rarely, on metapodials and phalanges. They indicate intensive filleting activities and, to a lesser extent, possibly the removal of tendons.

Impact notches were not observed on the mandibles, but two notches were present on scapula blades. Notches on long bones were systematically placed relating to the form of the bone shaft. Thus, impact notches on humeri were mainly placed on the flatter medial face of the bone shaft, on the flatter palmar face of the radius and on the flatter caudal face of the tibia. Radii were often spilt open by a series of blows along the shaft; distal ends were often removed by blows to the lateral and medial sides. Both ends of the tibia were removed and, along with distal radial epiphyses, were smashed into small fragments. Only six notches were observed on the femur, mainly on the lateral and caudal sides towards the distal end of the bone. Metapodials appear to have been opened mainly by blows to the proximal (metacarpals and metatarsals) articulation surfaces and distal articulation surfaces (metacarpal). Blows to the shaft are rare on metapodials. First phalanges were spilt open longitudinally by blows to the proximal or dorsal surfaces. Third phalanges appear to have been treated in the same manner, but second phalanges were almost always intact.

A comparison of the data from the sites

During the Magdalenian period, several sites in Europe were characterized by faunas where horse was the dominant species or the most common species in an otherwise diverse fauna. The sites described here had different functions. Solutré appears to have been used solely as a kill and butchery site, Hauterive-Champréveyres as a site where horse remains were mainly butchered. Andernach-Martinsberg and Marolles functioned as settlement sites. Hearths were revealed at Marolles, but no structures. Stable, circular habitation structures were found at Andernach. These were probably permanently in place, and probably inhabited on repeated occasions over a number of years.

The Magdalenian lithic inventories recovered at these sites are dominated by a range of tool types or a

particular tool eg. backed blades, burins and borers at Solutré, burins, scrapers, backed blades, points and »becs« at Marolles, backed blades at Hauterive-Champréveyres. Detailed analyses of the spatial organization of lithic artefacts at Andernach have shown that particular tool types (as well as raw material types) are associated with different structures at the sites.

Although the faunas recorded from the sites considered here are diverse ones with numerous species present, horse dominates in terms numbers of identified specimens (NISP), minimum number of individuals (MNI) and/or in terms of its importance in the subsistence strategies of the occupants of the sites.

The highest number of horses was recorded at Marolles, where a minimum of 74 individuals was identified from 3,269 remains identified to this species from sector 1, sample A of the site. The total number of horses from the whole site could be as high as 150. This exceptionally high number seems to be unique for the Marolles site, and in general, numbers of individuals ranged between 12 at Andernach and 45 at Solutré (tab. 24).

Generally, all parts of the horse skeleton were present at the sites, but in varying proportions and sometimes only represented by one find (fig. 53). The dominance of teeth in the horse bone assemblage from Hauterive-Champréveyres is likely to be linked to the poor bone preservation recorded at this site, rather than selection of body parts by the Magdalenian hunters. Very low numbers of vertebrae and ribs, noted for example at Solutré, Marolles, Andernach and Hauterive-Champréveyres could also be related to bone preservation or, as at Solutré where some vertebrae appear to be better-preserved than others, the result of transportation of carcass parts away from the site by the Magdalenians. Similar alternative interpretations – bone preservation or human selection of certain carcass parts during butchery – were proposed to explain the low numbers of axial elements at Marolles. At Andernach low numbers of vertebrae were attributed either to the human destruction of these parts, as many vertebral fragments appear to have been pulverised or, when the equally low numbers of proximal ribs are considered, that proximal ribs and vertebrae were the parts left behind at the kill-site.

On the whole, horse age-profiles (resulting from analyses of eruption and wear stages of horse incisors and/or cheek teeth undertaken at some of the sites) showed that practically all age-groups are present and that the age-structures tended to be dominated mainly by adult animals, often those in their prime years. In figure 54, four age-profiles are depicted and even though slightly different methods of representation were employed – aged teeth expressed as a percentage of the total number of teeth sampled and placed in age-classes for Solutré P16; number of teeth and age in years for Grand Canton at Marolles; number and age in years for Hauterive-Champréveyres – the profiles can still be used for comparative purposes. The adult-dominated type of age-structure was identified at Solutré, where teeth from adults in their prime years formed 76% of the sample. At Marolles the age-structure was characterized by a high peak of young adults between 6-10 years of age. A peak between 6-10 years, a smaller peak between 11-15 years, and low numbers of juvenile and senile animals were recorded at Andernach. The underrepresentation of horses between 4 and 6 years of age at Andernach is rather unusual. The distinctive age-structure of the Hauterive-Champréveyres horses with very high numbers of young individuals, especially 2-3 year olds, absence of horses aged between 4 and 5 years, low numbers of 6-10 year olds and absence of senile horses may be due to the detailed method of age-analysis, where dentitions of individual animals were first reconstructed and then aged. A conventional analysis, in which crown-heights were measured and plotted as a sample without attribution to a particular individual was also undertaken at Champréveyres for comparative purposes, and produced the adult-dominated age-profile recorded at many of the other sites.

Whether adult-dominated age-profiles are simply a result of the method used, will have to be tested at sites which have produced large amounts of horse teeth. At the moment, all we can say is that adult-dominated age-profiles appear to be the ones most commonly found at Magdalenian sites. The presence of large numbers of adults, low numbers of canines indicating that the horses were mainly mares, presence of foetal bones and the presence of young foals all suggest that family groups were hunted at least some of the time at the sites considered here.

Site	NISP	MNI
Grand Canton, Marolles (sector 1, sample A)	3,269	74
Solutré (sector P16)	3,577	45
Hauterive-Champréveyres	2,956	13-21
Andernach-Martinsberg	2,201	12

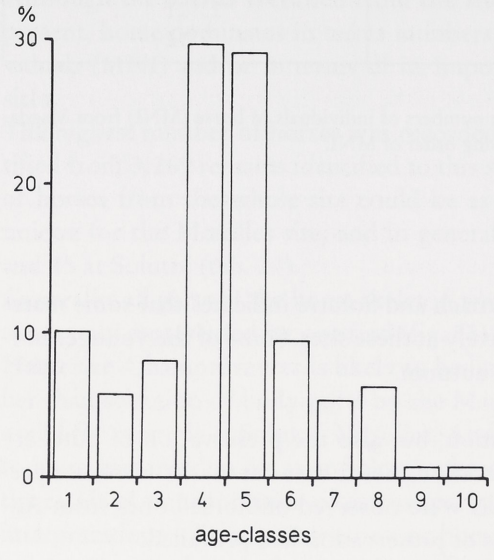
Tab. 24 Numbers of specimens identified to horse (NISP) and minimum numbers of individuals of horse (MNI) from Magdalenian sites in Europe, listed in decreasing order of MNI.

The stage of development of horse foetal bones from Andernach and Solutré indicates that some mares died in the winter and between February and March respectively at these sites. Some of the younger horses from Hauterive-Champréveyres died during spring and autumn.

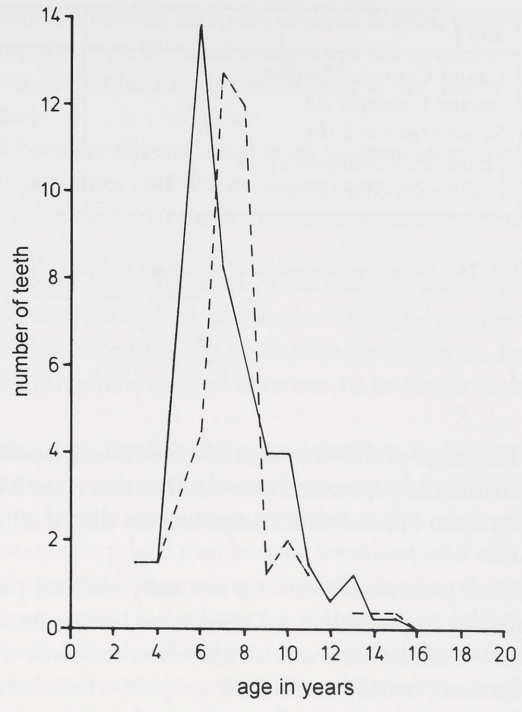
Bone preservation affects not only skeletal part representation, but also the preservation of butchery marks, in particular cut marks, on bones. Poor bone preservation meant that cut marks were not preserved on horse bones at Marolles, and only a few cut marks were observed on horse bones from Andernach, usually on finds from pits, where better conditions of preservation had prevailed.
Despite the low numbers of cut marks observed at some sites, several stages of carcass processing from skinning (Andernach and Solutré), removal of gingival tissue (Solutré and Andernach), evisceration (Solutré), carcass dismemberment and disarticulation (Andernach and Solutré) filleting (Solutré, Andernach), and tendon and sinew removal (Solutré and possibly at Andernach and Hauterive-Champréveyres) had been carried out. The carcass may have been hung at Solutré (sector I11).
Minor differences were noted in the proportions of certain types of cut marks from site to site. At the kill-site at Solutré, the bulk of the cut marks had been produced during dismemberment or disarticulation of the horse carcass rather than during other activities. The same was observed at the settlement site at Andernach, where the majority of the cut marks were located at major joints of the carcass and were produced during disarticulation; only a small number of cut marks was indicative of filleting activities. Exactly the opposite was the case at Hauterive-Champréveyres, where mainly filleting marks were observed and only a few disarticulation marks.
Cut marks on third phalanges were observed at Andernach, and were probably produced during removal of the hoof.

Horse bones were smashed open to obtain marrow at the majority of the sites described here. The systematic fracturing of horse bones to obtain marrow was logically related to their form. Thus, impact notches were more commonly found on the flatter faces of shafts of bones such as the tibia and the radius, rather than on the rounded shaft of the femur. Straight-sided bones such as the radius and the metapodials were often split open longitudinally by a series of blows to the shaft as recorded at Andernach, Solutré and Hauterive-Champréveyres. The use of anvils as supports during bone-smashing is shown by the presence of opposing, reflected notches on bones from Solutré and Andernach. At Hauterive-Champréveyres third phalanges were also systematically opened. The intensive crushing of cancellous bone for extracting juice and fat has been observed at Andernach.

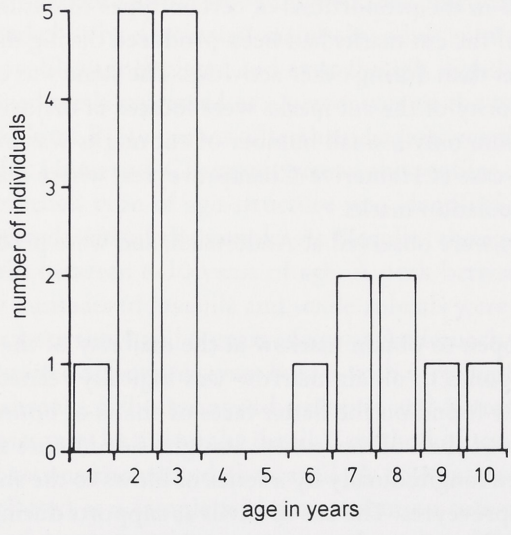
Horse bones, particularly the fractured off distal ends of metapodia, utilized as cores for the production of bone needles have been recorded from Solutré and Andernach. At Solutré (sector I11), a depiction of a reindeer had been engraved on the iliac bone of the pelvis of a horse.



SOLUTRÉ P. 16



GRAND CANTON, MAROLLES



HAUTERIVE-CHAMPRÉVEYRES

Fig. 54 Comparison of horse age-structures from selected Magdalenian sites in Europe. Data for Solutré P16 taken from figure 11, this volume; Grand Canton, Marolles after Bémilli 1994, fig. 23, black lines = upper teeth, broken lines = lower teeth; Hauterive-Champréveyres after Morel and Müller 1997, fig. 45.

The simple answer to this question is, no. Horse dominated faunas or faunas where horse is the most common species present, and evidence for the human exploitation of horse carcasses have been revealed at several Lower and Middle Palaeolithic sites in Europe. In level G at La Caune d'Arago in the south-west of France, dated to about 420,000 or 450,000 BP (Bellai 1995; Moigne and Barsky 1999) or according to some authors beginning of Saale (Desclaux 1992), horse is the resource most commonly exploited by the human occupants of the cave, representing 60% of a total of 70,000 finds from this level. 74 individuals have been identified. Cut marks, indicating skinning, disarticulation and filleting activities, were recorded and many horse bones had been fractured, presumably to obtain marrow (Bellai ibid.).
Wooden spears, recently discovered during investigation of Lower Palaeolithic sites in the brown-coal lignite mine at Schöningen near Hannover, provide undisputable evidence that humans already possessed a technology capable of producing sophisticated, long-distance, hunting weaponry at around 400,000 BP. The remains of more than 15 individuals of horse (counted on horse skulls) were associated with the spears. Many of the bones bear traces of cut marks and fracturing to extract marrow. The evidence from Schöningen suggests that herds of horses were systematically hunted using long-distance weapons and processed afterwards at the site (Thieme 1997, 1999).
Another method of obtaining horse meat has been interpreted from remains found at the karstic aven of Igue des Rameaux in France (Bas Quercy). Horse is represented by skulls (about 12), mandibles, isolated teeth, intact long bones – some in anatomical connection – and some vertebrae. The presence of canine teeth in the skulls and mandibles of the horses, and tooth eruption and wear stages suggests that a group of juvenile and young adult (males?) fell into the aven which served as a natural trap and died there. A small number of lithic artefacts, comparable to local Lower Palaeolithic or early Middle Palaeolithic inventories, were associated with this fauna; however, there are no traces of human modification on the horse bones. It has been suggested that humans regularly controlled avens in this region, knowing that animals would fall into them from time to time. The remains from Igue des Rameaux have been interpreted as evidence of controlled and active scavenging as part of the subsistence strategies of Lower Palaolithic humans (Rouzaud et al. 1990; Brugal and Jaubert 1991).
The Kulna cave is located on the northern edge of the Moravian Karst (Valoch et al. 1969). All of the deposits at this site are rich in faunal and archaeological finds, the most important layer is level 11, which was deposited during Stage 5 of the oxygen isotope stages (Svoboda et al. 1996) from which many remains of horse (MNI 35) have been recovered. Teeth are the most common elements in the assemblage of horse bone; post-cranial bones are underrepresented. Numerous shaft fragments and teeth lacking roots, attest to the systematic fracturing of both long bones and mandibles to obtain marrow. Many bones with cut marks have been observed. The ages of the horses range from very young to relatively old (Musil 1969, 1990). Horse metapodials from this site bear traces on their surfaces consistent with their use as retouchers (Valoch 1968/69; own observations, April, 1999).
Horses are also common elements of the fauna from the Middle Palaeolithic site of Ille-et-Vilaine at Mont Dol near the coast of Brittany. Faunal remains and Mousterian artefacts were recovered from a series of flow deposits stratified above the Eemian Interglacial beach and probably dating to the first cold phase following the climatic optimum of the Eemian. Horse (MNI 54) and mammoth (MNI 34) (Simonet and Monnier 1991, tab. 1) are the most common species in this diverse fauna, both in terms of numbers of finds identifiable to a species and minimum numbers of individuals. Cut marks indicating dismemberment were observed on only two horse bones – the pelvis and the rear hock. Cut marks indicating filleting were found on a vertebra, and on the shafts of metapodials. A fragment from the skull has been charred. In contrast to this, many horse bones had been systematically fractured (Langouet and Morzadec-Kerfourn 1995; Simonet and Monnier 1991).
It has been suggested that the site at Mont Dol may have functioned in much the same way as the neighbouring site at La Cotte de St. Brelade (Simonet and Monnier 1991). The ravines at La Cotte were used

as a natural pitfall for large quantities of rhinos and mammoths, as part of a Middle Palaeolithic subsistence strategy combining wide-ranging hunting of many different species with occasional large game kills in the ravines at the site (Callow and Cornford 1986). However, the early date of Mont Dol's discovery, and the subsequent destruction of the site make this suggestion difficult to verify.
The Middle Palaeolithic site at Zwolen is located about 120km south-south-east of Warsaw, on the southern slope of the Zwolénka Valley. The faunal remains and lithic artefacts are stratified in alluvial and niveo-eolian sediments which accumulated in a series of depositional cycles dating to between 80,000 and 74,000 kyr (Thermoluminescence dating) (pers. comm. A. Gautier, 1999).
Horse is the most common species among finds found up to the end of 1985, and over 30 individuals are present. Cut marks are rare, although wear traces on stone tools show that the cutting of wet hides and bone scraping was carried out at the site. Information relating to impact notches has not been published so far. Zwolen has been described as a multiple kill site, where mainly horses were driven to their death and butchered afterwards at the site (Gautier 1989, Schild and Sulgostowska 1988).
Other Middle Palaeolithic sites at which horses are common in the faunas are Grotte du Docteur (Ulrix-Closset 1975) and Grotte de Ramioul (Vandebosch 1921) in Belgium; in France, Genay (Patou 1988), Combe Grenal (layer 14) (Chase 1986), Ioton in Languedoc, Champ-Grand and Baume-Vallée in the Massif Central region (Brugal and Jaubert 1996); and layer 5 at Achenheim in Alsace (Wernert 1957). In Germany, horses are also the most common species in Middle Palaeolithic deposits at the cave of Bocksteinschmiede, IIIa (Wetzel and Bosinski 1969) and in layer III at the Vogelherd (Lehmann 1954). At the latter site, relatively numerous horse remains were also found in the Upper Palaeolithic levels belonging to the »Aurignac« and Magdalenian phases.

The long history of excavation and investigation at Solutré has shown that this site was occupied during the Mousterian, Aurignacian, Gravettian, Solutrean and Magdalenian periods. The dominance of horses in the faunas from these levels was recognised during the earliest investigations at this site, and the way in which horses in particular were hunted and processed at Solutré formed the focal point of several archaeozoological analyses undertaken by Hubert Berke, Marsha Levine, Sandra Olsen and Marie-Luise Tretschocks in the 1970's and 1980's.
In this report, data collected during an examination of faunal remains from Magdalenian deposits in sectors I11 and P16 at Solutré are presented. Focussing on skeletal part representation, age-structures, sexual demography, season of death and traces of bone modification in the form of cut marks, impact notches and carnivore gnawing, the faunal assemblages from these sites were analysed. The Magdalenians hunted mainly horses at Solutré, but also took relatively high numbers of reindeer and bison. Time of death of horses, reindeer and bison suggests that the site was probably used at varying times of the year, and that groups of juvenile reindeer and juvenile bison were possibly hunted on a seasonal basis. One of the characteristics of the faunal assemblage are the low numbers of humanly modified bones and the relatively high numbers of bones gnawed by carnivores. However, the most important aspect of Solutré is the evidence that the locality mainly functioned during the Middle Palaeolithic and Upper Palaeolithic periods as a horse hunting site. As Olsen (1989) states, the evidence from the cultural levels Solutré demonstrates a continuity of the organized hunting of horses and horse carcass processing, stemming from considerable understanding of horse behaviour, regular patterns of horse migration throughout these periods and a social organization capable of conducting a communal hunt.
Recent evidence now demonstrates that herds of horses were systematically hunted as early as 400,000 BP at Schöningen, and that at around 420,000 or 450,000 BP, horse carcasses at La Caune d'Arago were prepared using butchery techniques similar to those employed by the Magdalenians at Solutré. The continuity observed in levels dating from the end of the Middle Palaeolithic throughout the Upper Palaeolithic at Solutré, can now be traced back into the Lower Palaeolithic period.

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