Chapter 8

The elephant skeleton and the question of human exploitation

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INTRODUCTION

This chapter explores the question of whether humans were involved in the accumulation and modification of the large mammal remains. It follows two lines of evidence; firstly the association of the elephant skeleton with refitting Clactonian artefacts and, secondly, the evidence from cut marks. The focus of the first part of the chapter is the elephant skeleton itself, which has received a great deal of attention because of its preliminary interpretation as a rare example of Lower Palaeolithic elephant butchery. A detailed account of the taphonomy of the elephant skeleton aims at documenting the sequence of taphonomic events from the death of the elephant up to the chance discovery and excavation of its disarticulated and poorly preserved skeleton in 2004. The depositional and environmental context of the bones is also discussed. Age at death, gender and body-size are inferred from an analysis of the bones. These results are integrated with the stone tool evidence in Chapter 17. The second part of the chapter outlines the results from a careful search for cut marks and evidence for marrow extraction. Given the abundance of stone tools at the site, it is surprising that only two cut-marked bones were recorded. The chapter concludes with a discussion of the scant evidence for Clactonian butchery practices and a review of elephant butchery in a wider European Palaeolithic context.

Figure 8.1 The Ebbsfleet elephant remains during excavation: the poor condition of the tusks is evident. [Photo MR Bates]

Table 8.1 List of elephant bones from Southfleet Road, contexts 40078 and 40144.

Context	Find no. Δ	Element	Comments
40078			
	40060	L M^3	
	40499	R M^3	
	40362	Tusk frag	
	40363	Tusk frag	
	40402	Tusk frag	
	40411	Tusk frag	
	40412	Tusk frag	
	40526	Tusk frag	
	40527	Tusk frag	
	40529	Tusk frag	
	40573	Tusk frag	
	40574	Tusk frag	
	40685	Tusk frag	
	40691	Tusk frag	
	40925	Tusk frag	
	40927	Tusk frag	
	40933	Tusk frag	
	40998	Tusk frag	
	41002	Tusk frag	
	41004	Tusk frag	
	41082	Tusk frag	
	41356	Tusk frag	
	41439	Tusk frag	
	41442	Tusk frag	
	41448	Tusk frag	
	41457	Tusk frag	
	41494	Tusk frag	
	41948	Tusk frag (tip)	
	41444b	Tusk frag	
	40406	? Skull frag	
	40524	? Skull frag	
	40535	? Skull frag	
	41197	? Skull frag	
	40931	Cervical vertebra frag	Articulates with Δ. 41490
	41490	Cervical vertebra frag	Articulates with Δ. 40931
	40990	Cervical vertebra frag	
	40942	Cervical vertebra frag	
	40080	Thoracic vertebra centrum	Cranial & caudal unfused
	40773	Thoracic vertebra	
	40887	Lumbar vertebra	Almost complete (spine missing). Cranial unfused, caudal fusing
	40781	Lumbar vertebra centrum	Cranial unfused, caudal fused
	40999	Thoracic vertebra	
	40780	Thoracic vertebra	
	40079	Vertebra frag	
	40707	Vertebra frag	
	40779	Vertebra frag	
	40798	Vertebra frag	
	40938	Vertebra frag	
	40769	Vertebra frag	
	40074	? Vertebra frag	
	40784	? Vertebra frag	
	40598	Rib frag	
	40684	Rib frag	
	40703	Rib frag (proximal end)	
	40704	Rib frag	
	40596	Rib frag	
	40765	Rib frag (with ?skull frag)	
	42926	Rib frag	
	40516	Rib frag	
	40533	Rib frag	
	43493	? Rib frag	
	41021	? Rib frag	
	41033	? Rib frag	

THE EBBSFLEET ELEPHANT

The excavation took place under rescue conditions and the dry clayey nature of the subsoil contributed to the difficulty of excavating the fragile and fractured elephant remains (Fig. 8.1). Most of the bones were missing and only 47 fragmentary identifiable elephant elements, two molars, two substantial portions of the left and right tusks and 27 tusk fragments were recovered (Table 8.1). These include both cranial and postcranial portions, but notably absent are the pelvis, long bones as well as most of the other limb bones. Nearly all of the elephant bones were found in a cluster covering an area of approximately 25m^2 (Fig. 8.2), with a separate scatter of articulating foot bones some 20-30m to the north-east. In addition, 159 specimens are too fragmentary to identify to element, but can only have come from an elephant due to their size and cortical thickness. There is no duplication of bone elements and all are consistent in size and ontogenetic age, implying that all of the bones pertain to a single extremely large adult individual (Appendix D5).

The elephant skeleton was largely disarticulated and the remains were found in the central western part of the site, within the lower part of the grey silty clay (Phase 6 deposits) approximately 5m below the modern ground surface. The Phase 6 clay was up to *c* 3m thick, but most of the elephant bones were found in a single brown organic-rich horizon *c* 100mm thick (40078) at the base of the unit. This unit was brecciated with iron-mottled horizons and other darker organic-rich bands in the area of the elephant discovery. The brecciation and iron-mottling indicates fluctuating water levels with periods of desiccation and oxidation. The bone-bearing horizon slopes gently down towards the north, although the extent to which this is the result of post-depositional deformation is unclear. Although pollen was poorly preserved, traces of wood were noted during the excavation and numerous *Alnus* (alder) sieve plates (derived from the breakdown of wood) were observed in the palynological preparations (Chapter 12). It seems likely therefore that the elephant died in or immediately adjacent to a swampy alder carr. Associated vertebrate and palynological evidence suggests that the elephant lived during a period of fully temperate climatic conditions of the early-temperate substage of the Hoxnian interglacial.

Taxonomy

The identification of elephant skeletal remains is best determined from its cranium, tusks or cheek teeth. The tusks from Southfleet are badly crushed and deformed, but the upper third molars are more-or-less intact. The right molar was dislodged during section cleaning (see Chapter 3) and was damaged by the mechanical excavator. The morphology of the molars corresponds in all respects to the extinct straight-tusked elephant *Palaeoloxodon antiquus* (Fig. 8.3). Features diagnostic for *P. antiquus* include a narrow crown with well-spaced, lozenge-shaped lamellae (plates) that are broader in the middle of the tooth than their extremities and thick enamel. Taxonomic identification of elephant postcranial remains is less straightforward (Lister and Stuart 2010). Nonetheless, the exceptionally large size of the Ebbsfleet elephant bones (including the dispersed carpals and metacarpals), their lack of duplication and their proximity to the identifiable molars suggests that they are almost certainly from the same *P. antiquus* individual.

Age at death

The age of death of elephant can be determined from the state of fusion of the postcranial skeleton and from the eruption and wear state of the cheek teeth (Haynes 1991). The third upper molars are in early wear indicating a prime-aged individual of about 43-49 years old (Appendix D5). Fusion state could be recorded for the metacarpals and second phalanx, which all have fused distal epiphyses, whereas some of the vertebral plates were either unfused or only partially fused at the time of death (Table 8.1, Fig. 8.4). This indicates that animal was not quite skeletally mature. Given the typical pattern of elongated skeletal growth period in elephants, the age estimates derived from teeth are not inconsistent with the fact vertebral epiphyses were not all fully fused.

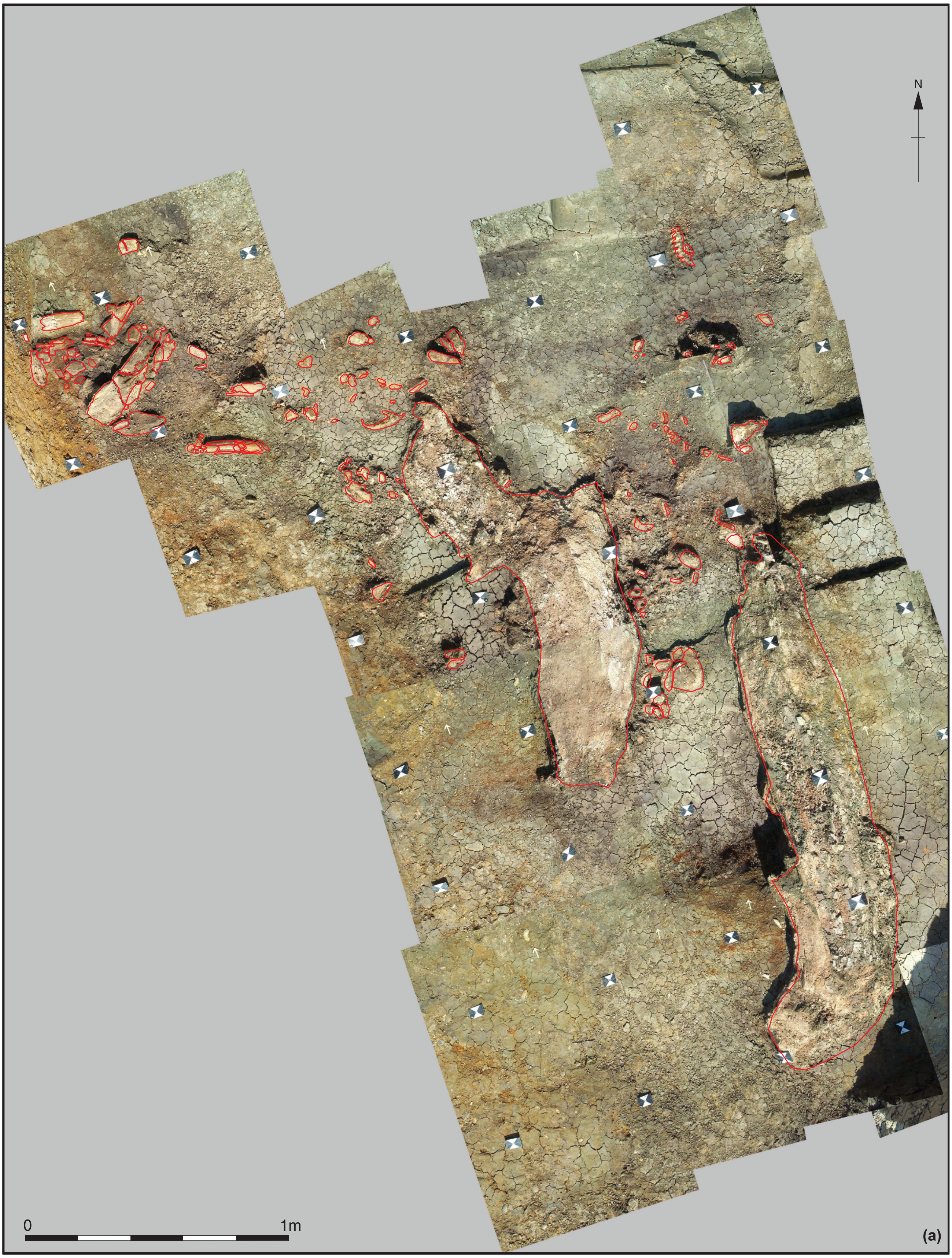
Table 8.1 (continued)

Context	*Find no. Δ*	*Element*	*Comments*
	40534	L. scapula frag	Conjoins with Δ. 40824
	40824	L. scapula frag	Conjoins with Δ. 40534
	42255	R. magnum	Articulates with: Δ. 41947b, Δ. 42411, Δ. 42412
	42411	R. trapezium	Articulates with: Δ. 42412, Δ. 42255
	41947b	R. unciform	Articulates with: Δ. 42255 & Δ. 42148
	42148	R. metacarpal IV	Articulates with Δ. 41947b
	42975	Metacarpal (crushed)	
	42412	R. metacarpal II	Articulates with: Δ. 42255, Δ. 42411
	42974	Metapodial frag (distal end)	
	42863	2nd Phalanx IV	
40144			
	43378	R. cuneiform	

Abbreviations: frag – fragment; L. – left; R. – right

Gender and body size

The gender of elephant skeletons is best determined from its pelvic bones, skull or tusks (Lister and Agenbroad 1994), but in the absence of these some indication can be gleaned from body size. Skeletons of African and Indian elephants exhibit a considerable size range, related to age, sexual dimorphism and individual variation. Kroll (1991) has shown that the straight-tusked elephants were also sexually dimorphic in body



size, with a clear size difference between bones of adult male and female *P. antiquus*. Based on this work, estimates of shoulder height suggest that males may have reached 4.3m (range 3.80-4.30m, n=6), whereas adult females were generally smaller than 3.40m (n=3).

The bones of the Ebbsfleet elephant indicate an animal of extremely large body size, although comparisons and estimates of shoulder height are complicated by poor preservation of the material. The only complete measurable bones are from the carpus, which include the second metacarpal with a length of about 230mm. Of the published metacarpal measurements (Table 8.2), only those of the male individuals from Fonte Campanile and Upnor (Kent), elephants are larger (Andrews 1928). Shoulder height has been estimated for the Crumstadt elephant (with the shorter metacarpal) and for the Upnor elephant. Following these criteria, the subadult individual from Crumstadt had a shoulder height of some 2.90m (Kroll, 1991), whereas the massive Upnor elephant has an estimated height at the shoulder of about 4m. The Ebbsfleet elephant was probably of comparable size, although somewhat smaller than the Upnor elephant (Fig. 8.5a,b). The bones of the Selsey (Sussex) elephant (a probable female) are considerably smaller, as shown in Figure 8.5c,d. Such size differences are almost certainly due to sexual dimorphism. Based on its extremely large size, the Ebbsfleet elephant was almost certainly a male.

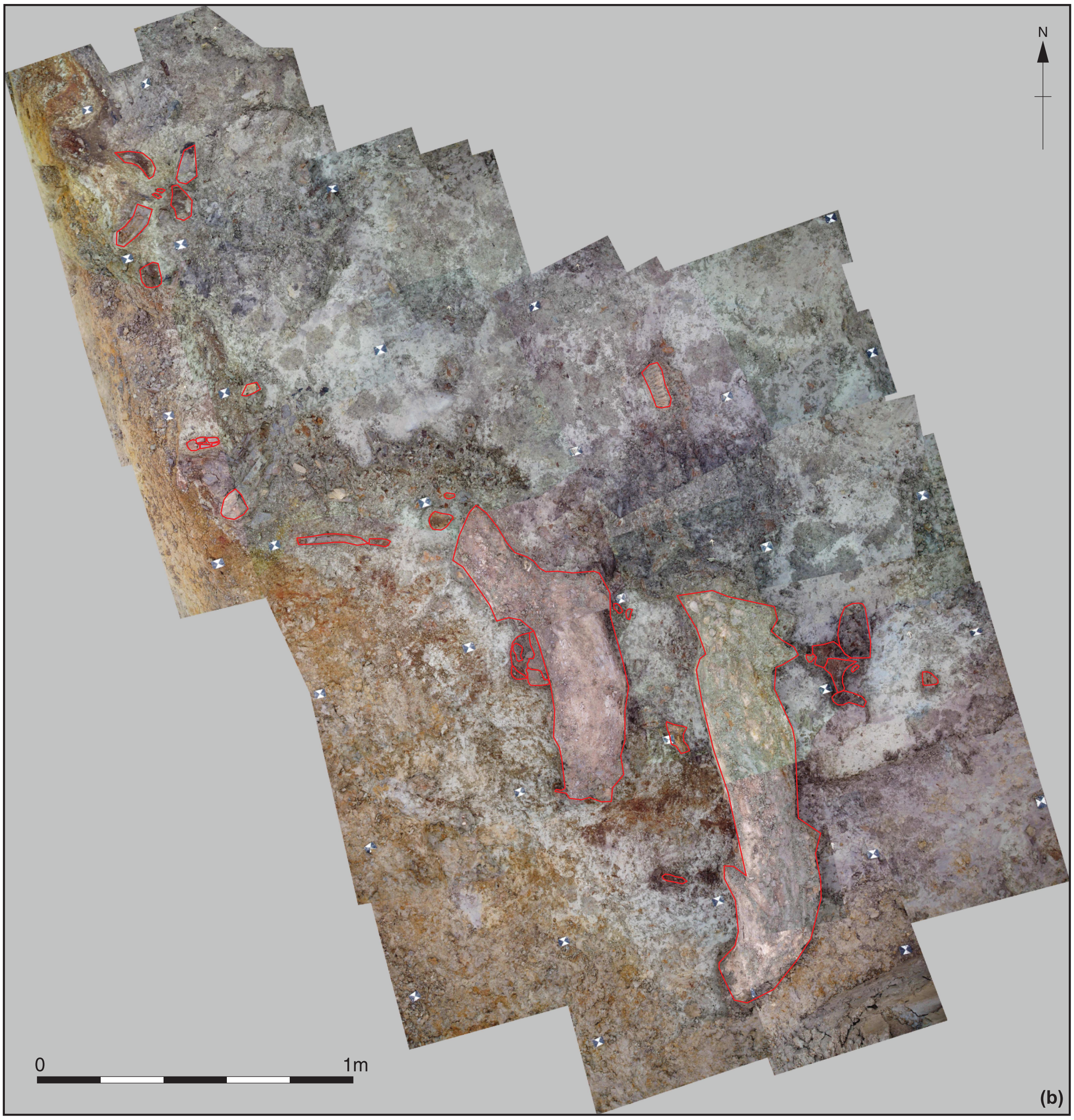


Figure 8.2 *(left, above and overleaf)* Geo-rectified vertical photographs of the main cluster of elephant bones (outlined in red) at Southfleet Road during successive stages of excavation (latest–earliest a–c). The poor condition of the larger bones is due to a combination of weathering before burial and soil corrosion, decalcification and mechanical damage during burial.

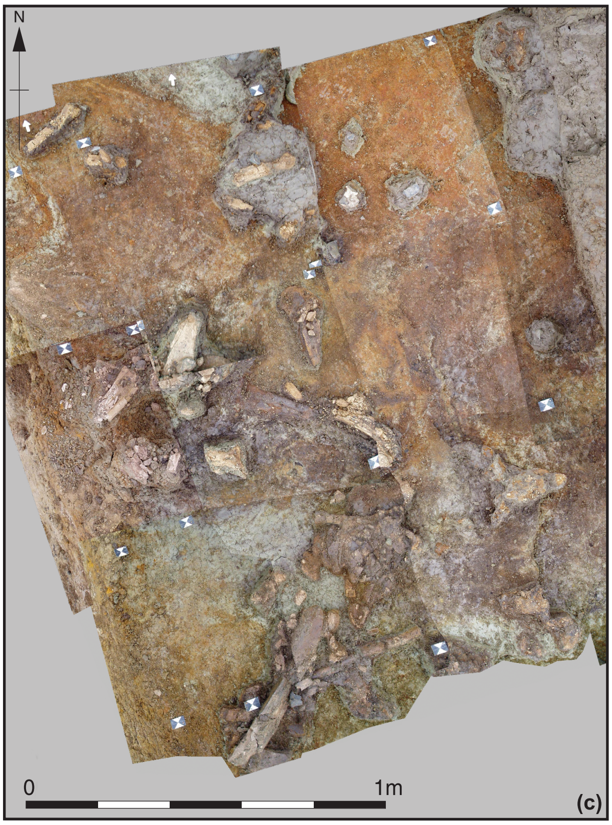


Table 8.2 Measurements of the second metacarpal from the Southfleet Elephant, in comparison with those from other *Palaeoloxodon* skeletons

	Length (mm)	
Crumstadt, Germany[a]	160	Female, subadult
Gröbern II, Germany[b]	179	Female, adult
Riano, Italy	175	Male, adult
Ciechanow, Poland[b]	189	Female, adult
Warschau, Poland[b]	206, 209	Male, subadult
Gröbern I, Germany[b]	217	Male, adult
Jozwin, Poland[b]	226	Male, adult
Southfleet Road	~230	Male, adult
Upnor[c]	233 c	Male, adult
Fonte Campanile, Italy[d]	237 d	

[a] Kroll (1991), Table 15
[b] Kroll (1991), Table 49
[c] Andrews (1928) gives a slightly smaller measurement of 227mm for this specimen.
[d] Estimated from illustration in Trevisan (1947 fig. 25)

Figure 8.2c *(left – caption on page 209)*

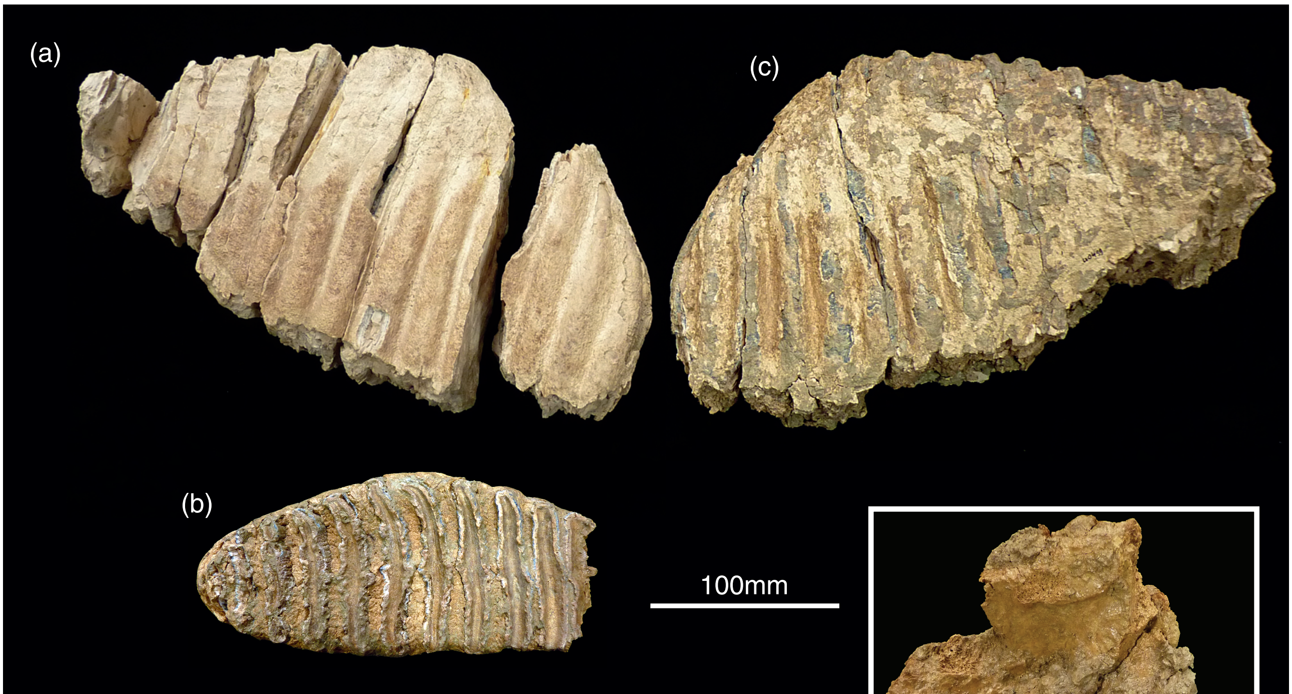


Figure 8.3 *(above)* Third upper molars (M^3) of the Ebbsfleet elephant (a-b): Side view (a) right M^3 (Δ.40060); (b) left M^3 (Δ.40499); (c) occlusal view (Δ.40499)

Figure 8.4 *(right)* Lumbar vertebra (Δ..40887), in posterior view. Note partial fusion of caudal bony plate with the body

Taphonomy

Skeletal element representation

Although bones from the skull, fore limbs and torso are represented, the hind limbs were entirely missing (Fig. 8.6). Other bones that were absent include the sacrum, caudal vertebrae and the mandible. Long bones are also conspicuous by their absence, although several of the pieces identified as indeterminate 'elephant-sized' bones appear to be diaphysis fragments. The skeletal elements identified are:

Skull and teeth

Two substantially complete tusks (up to 2m long) were too fragile to recover intact. Many smaller comminuted

Figure 8.5 Metacarpals of straight-tusked elephant from Southfleet Road, Upnor (Kent) and Selsey (West Sussex): (a) Second metacarpal (Δ.42412) of the Ebbsfleet elephant; (b) second metacarpal from the Upnor elephant, (M. 11156); (c) third metacarpal from Selsey; (d) third metacarpal from Upnor. The photograph illustrates the considerable size variation, which is almost certainly due to sexual dimorphism

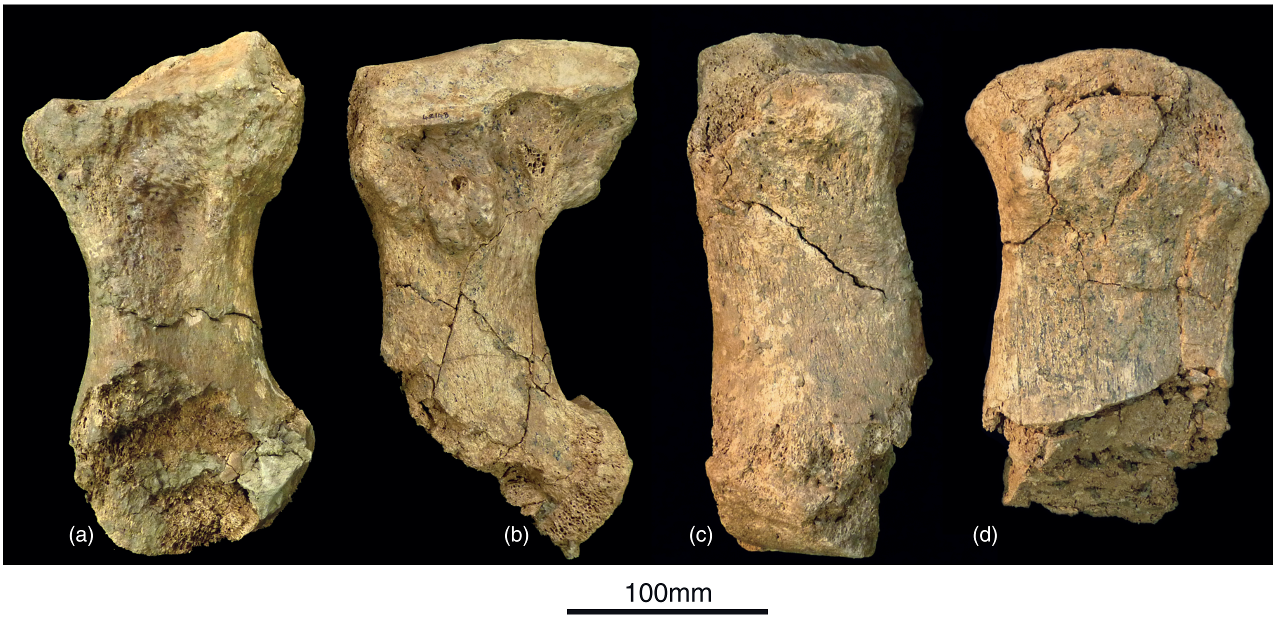


Figure 8.6 Metacarpals of the Ebbsfleet elephant: (a, c) second metacarpal (Δ. 42412); (b) (d) fourth metacarpal (Δ. 42148); in medial (a, b) and (c, d) anterior views

tusk fragments were found nearby and the tip of a tusk (not necessarily from the same individual) was recovered some 15m to the north-east. A small number of fragmentary bones were identified as possible cranial fragments. These were found together with pieces of tusk, and appear to be from the alveoli. The third upper molars are in good preservation state, although both are somewhat damaged at their ends.

Figure 8.7 First phalanx (Δ. 42863) of the Ebbsfleet elephant

Vertebrae and ribs
Elements from the vertebral column are represented by fragments of cervical (mostly articular processes), thoracic and lumbar vertebrae. Only one rib retained its proximal end, the other fragments consisting of entirely of blade fragments.

Scapula
A left scapula is represented by two substantial refitting pieces from part of the blade near the scapular spine.

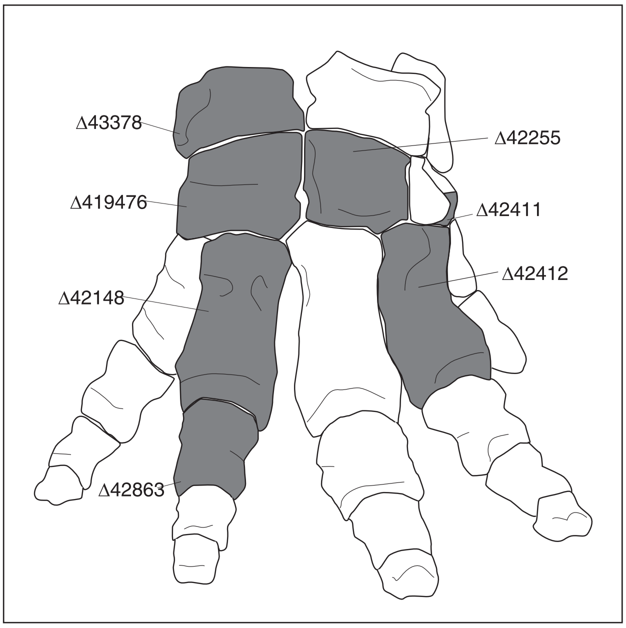


Figure 8.8 Elephant carpus, showing the bones present at Southfleet Road. With the exception of the cuneiform with damaged articular surface, the bones clearly articulate with one another in anatomical sequence

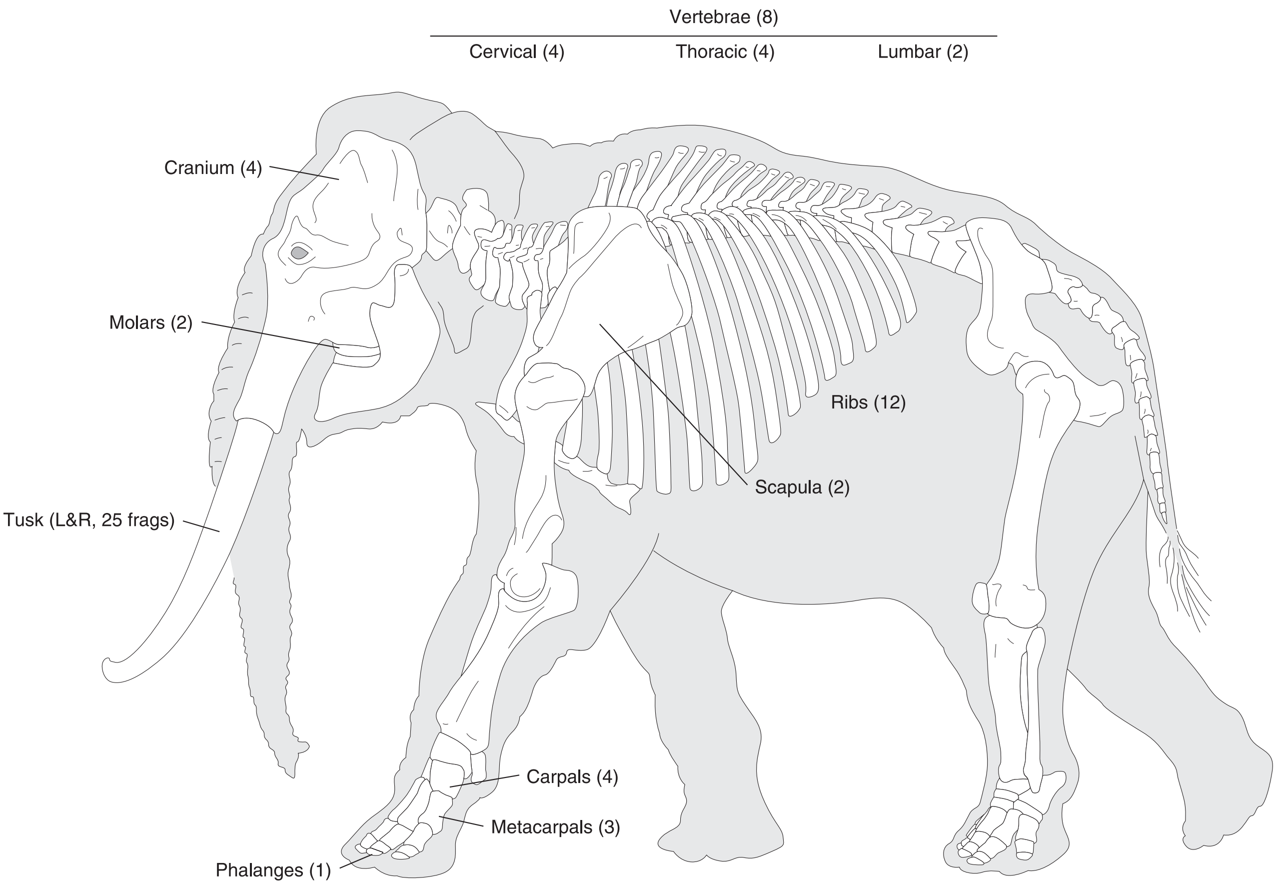


Figure 8.9 Numbers of bone fragments identified to skeletal element. The precise anatomical position of many of the pieces is uncertain due to the considerable fragmentation of the bones

Foot bones

Elements of the right carpus include unciform, magnum, trapezoid, three metacarpals (Fig. 8.7) and a phalanx (Fig. 8.8) from context 40078. The carpals and metacarpals articulate at their articular facets showing that they are from a single individual. The articular facets of the right cuneiform from context 40144 are damaged, but it is most certainly part of the same foot, given its large size and proximity to the other foot bones (Fig. 8.9).

The preceding catalogue highlights the fact that the collection represents no more than about 5% of the elephant skeleton (Fig. 8.6). This raises questions about the processes that led to the loss of the bulk of the skeleton.

Preservation and anatomical distribution of bones

Plots of the bone distribution show that the vast majority of elephant remains were confined to a relatively tight cluster located at the very western edge of the site (Fig. 8.10). Very few elephant bones were found beyond this area, and the distribution of bones to the west of the main cluster is unknown as this part of the site was truncated by mechanical excavation. It is certain that some of the elephant skeleton was lost to mechanical excavation, as some of the surviving bones were cut in half by the excavator blade (Fig. 3.17). Bones in the main cluster include parts of the axial skeleton, ribs, scapula and the fragments of the cranium (Fig. 8.11). Two large portions of the left and right tusks and two upper molars were also present, but the mandible and lower molars were not recovered. The two largely complete, but badly crushed, tusks mark the southern end of the cluster. Overall, the scatter has a linear form, which is orientated approximately north-west to north-east. To the north and east of the core group is a more dispersed scatter of elephant bones that includes several rib fragments, the tip of a tusk and bones of the right carpus. The carpus bones were deposited along the edge of a shallow channel feature filled with calcareous tufaceous sediments; one of the foot bones (a right cuneiform, Δ.43378) was found in the upper fill (40144) of the tufaceous channel.

To assess the extent to which post-depositional and burial conditions contributed to the loss of bone material, the quality of bone preservation was analysed. This assessment adopted a four point scale with grading, from good (1) to poor (4). Specimens assigned to condition category 4 were denatured due to localised decalcification of the sediments and include pieces that have survived as little more than 'stains'. Preservation of

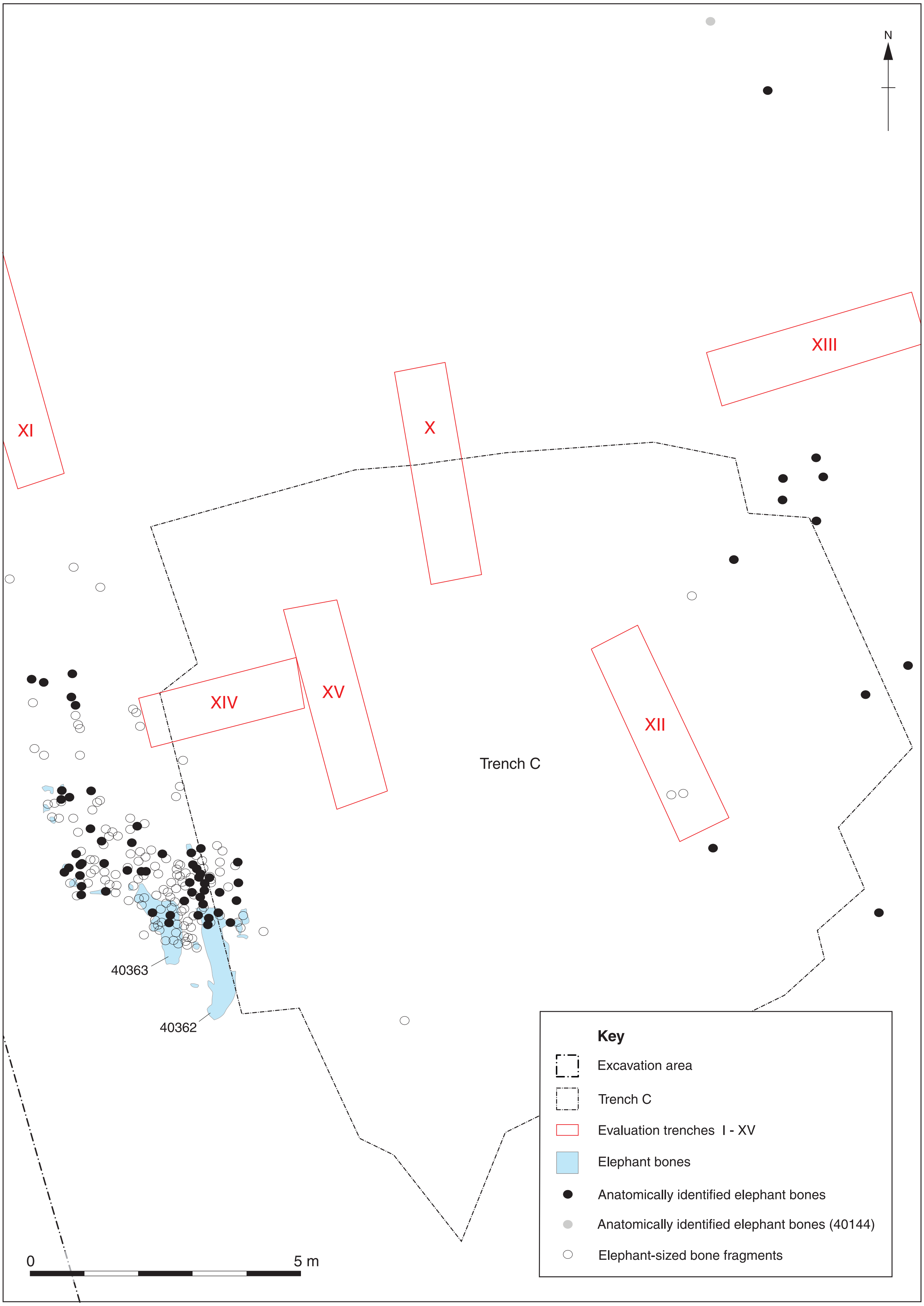


Figure 8.10 Plan of Southfleet Road, showing the distribution of elephant bones identified to element and non-diagnostic (elephant-sized) bone fragments

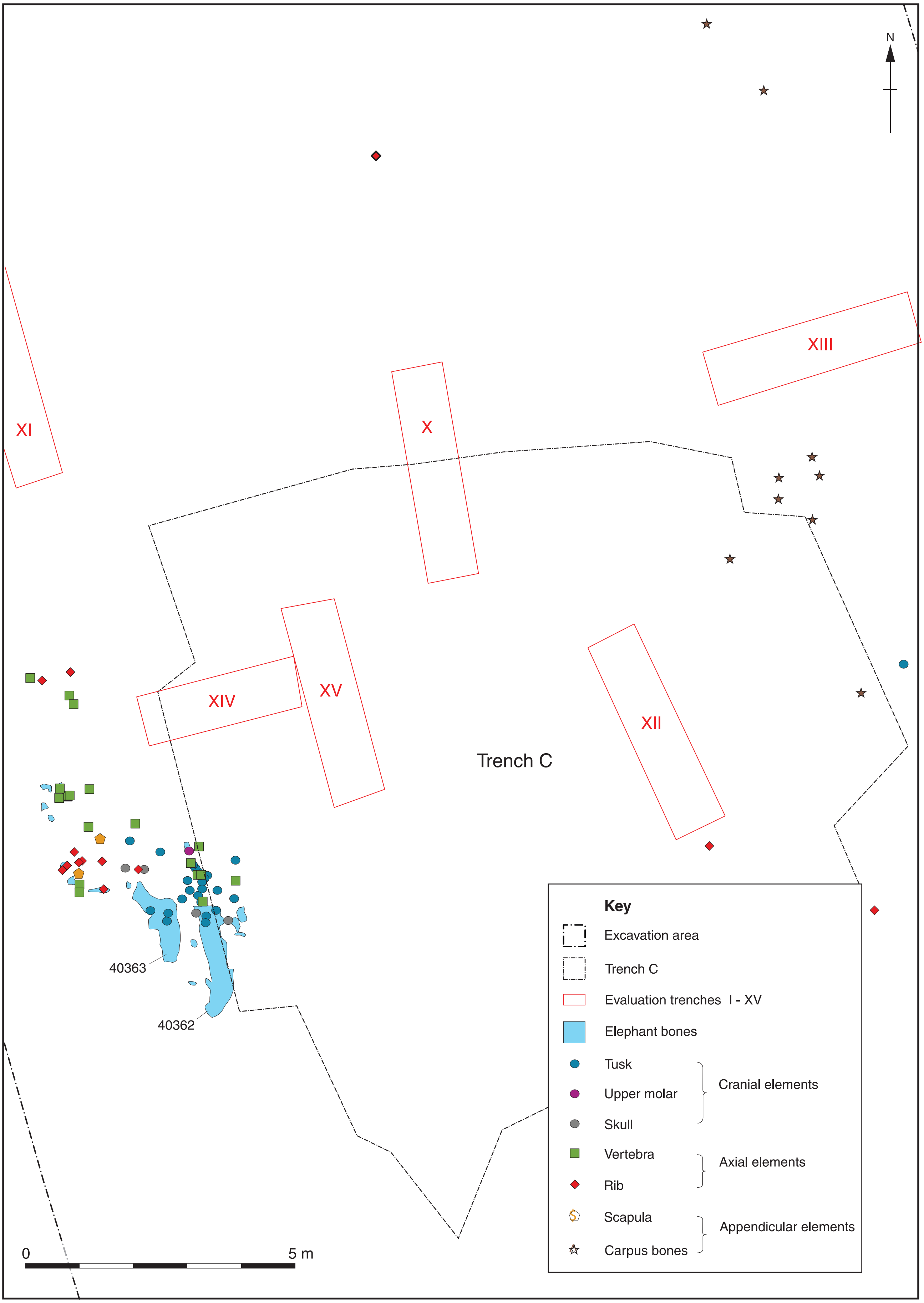
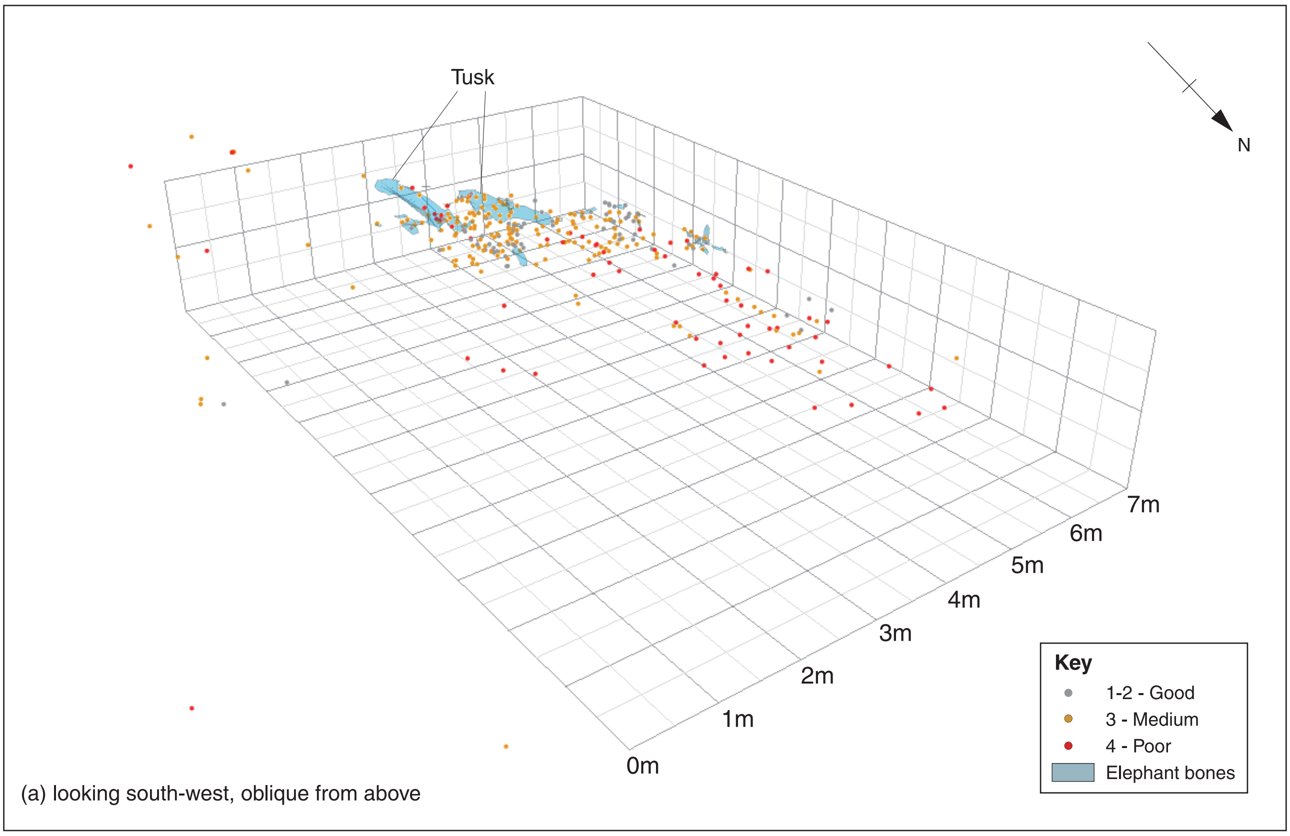


Figure 8.11 Plan of the Southfleet Road excavation showing the distribution of elephant remains according to body part



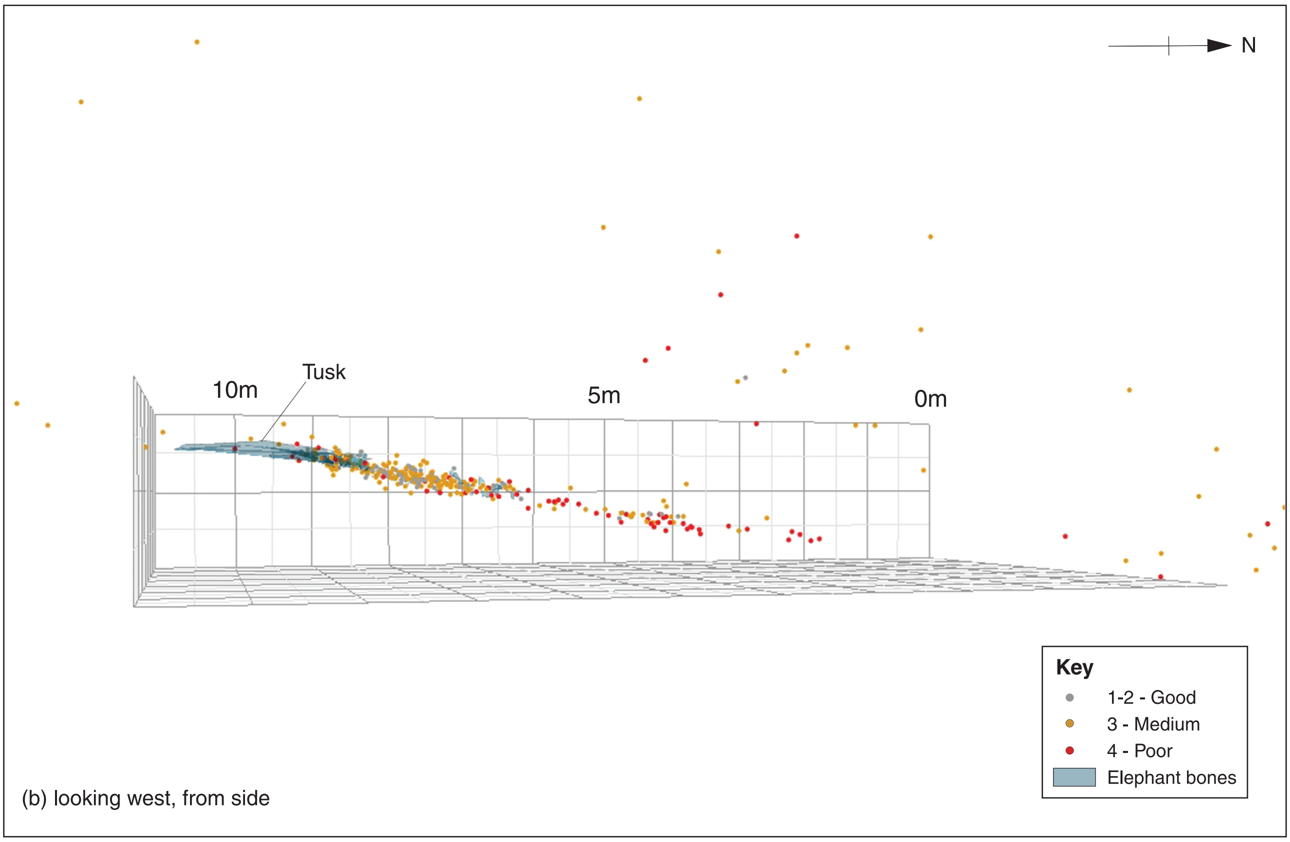


Figure 8.12 3-D plots of the main elephant-bone cluster showing variations in bone condition (1-4): (a) looking from south-west; (b) showing vertical distribution

the elephant bones is extremely variable; a few are not altered or corroded in any way, but most are in poor condition (Fig. 8.12). Fragmentation of the bones is often severe, with most of the bones sustaining fractures as a result of compression during burial. The tusks were in particularly poor condition, being crushed into splinters, although broadly retaining their original shape. The larger bone fragments were generally in an advanced state of disintegration having been subjected to compression and minor lateral movement within the clay. Lateral movement of the sediment body is indicated by slickenside striations in the surrounding sediment, with lateral movement of up to 50mm. Breakage from sediment compaction was compounded by repeated cycles of wetting and desiccation of the clay-rich matrix surrounding the bones, causing the peds to expand and contract. The effect of this process upon the bones was to create sediment-filled split lines and fissures, which has further weakened the bones. In addition, some of the large bones were damaged by mechanical excavation before their discovery. The foot bones close to the edge of the channel were in better condition, possibly due to the higher calcium carbonate content of the sediments associated with the tufaceous channel fill. Heavy post-depositional corrosion has affected fourteen of the bones, which survive as little more than stains or decomposed and crumbly bone (Fig. 8.12).

The state of preservation of bone surfaces is also extremely variable. This spectrum includes pieces with fresh, well-preserved surfaces, while others have lost much of the outer layer of cortical bone. The bones with fibrous, pitted or corroded surfaces may have been exposed to weathering before burial, but much of the corrosion appears to have occurred after burial. This type of surface degradation arises from chemical processes below ground chiefly due to soil conditions, temperature and moisture fluctuations in a biologically active soil and leaching of calcium carbonate (decalcification). Of the bones with well-preserved surface, none bear obvious traces of rounding due to water transport or signs of surface weathering. The smaller pieces of bone are unlikely to have been exposed for any considerable period of time, and were probably rapidly covered by sediment soon after death. In contrast, the largest bones, such as the skull and limb bones were probably exposed on the ground surface for some years, becoming weathered and fractured in the process. Polishing and fine parallel scratches (trample marks) were observed on a small number of the elephant bones. The polishing is likely to be from post-depositional processes and caused by the expansion and contraction of the matrix and slickensiding. Manganese dendrites were present on 42 pieces.

Carcass decay, disarticulation and bone breakage

An examination of the spatial distribution of the skeletal elements has proved invaluable for interpreting the sequence of carcass decay, disarticulation and movement of body parts away from the main cluster of elephant bones. Critical evidence is provided by the degree of bone disarticulation and scattering together with the spatial distribution of bones from different 'zones' of the body. The distribution of carcass components is presented in a series of schematic plans (Figs 8.13-16). Certain general patterns emerge. Firstly, there is a degree of clustering of different skeletal elements that reflects anatomical position within the skeleton (Fig. 8.13). This patterning is best illustrated by the distribution the tusks, vertebrae and ribs, which are in close spatial proximity and retain some resemblance of anatomical order (Fig. 8.14). Also notable is the linear arrangement of the vertebral fragments, which would appear to mark the position of the vertebral column (Fig. 8.14). From the general distribution of bone elements it is possible to infer that the elephant was lying on its left-hand-side. Before the bones were scattered, the skeleton was probably orientated north–south, with the head at the southern end. Much of the rear part of the skeleton would therefore have been located in the area that was dug-away during road construction.

Studies of elephant death sites have shown that some of the bones were not scattered but remain close to where the animal died. Bones remaining at the death site typically include the skull, vertebrae and ribs (Haynes 1988; 1993). These are the elements represented in the main scatter at Southfleet Road giving credence to the view that this area marks the location where the animal died. Observations of carcass decay in natural situations have also shown that the disarticulation of large herbivore skeletons is non-random and predictable (Hill and Behrensmeyer 1984). For example, fore limbs commonly separate off as a single unit and generally disarticulate sooner than the hind limbs. The scapula detaches from the body as the muscles decay, whereas the distal limb bones are held together by stronger ligamentous attachments. The distal elements and feet are often removed at an early stage of carcass decay. It is a commonly observed stage in the dispersal of mammalian skeletons for the proximal hind limbs, axial skeleton and cranium to be preserved at the death site with the feet and fore limbs removed. The diffuse scatter of elephant bone fragments to the east of the main cluster comprises mostly small bone fragments. Whether these were initially complete and broken after transport is unclear. Some of the bones missing from the main cluster were dispersed up to 30m from the carcass (Figs 8.13 and 8.16). Several mechanisms may be invoked to explain the movement and breakage patterns. For example, the dispersal of the bones may have involved scavenging carnivores, the trampling activity of large mammals or transport by flowing water and down-slope movement. Carnivores such as lion, bear and wolf would have been attracted to the carcass, although no unequivocal traces of carnivore chewing were observed. This is somewhat surprising as the assemblage includes bones with well-preserved cortical surfaces and spongy bones that would have been attractive to carnivores. The latter group includes the spongy foot bones, which would have been favoured by scavenging carnivores (Stuart and

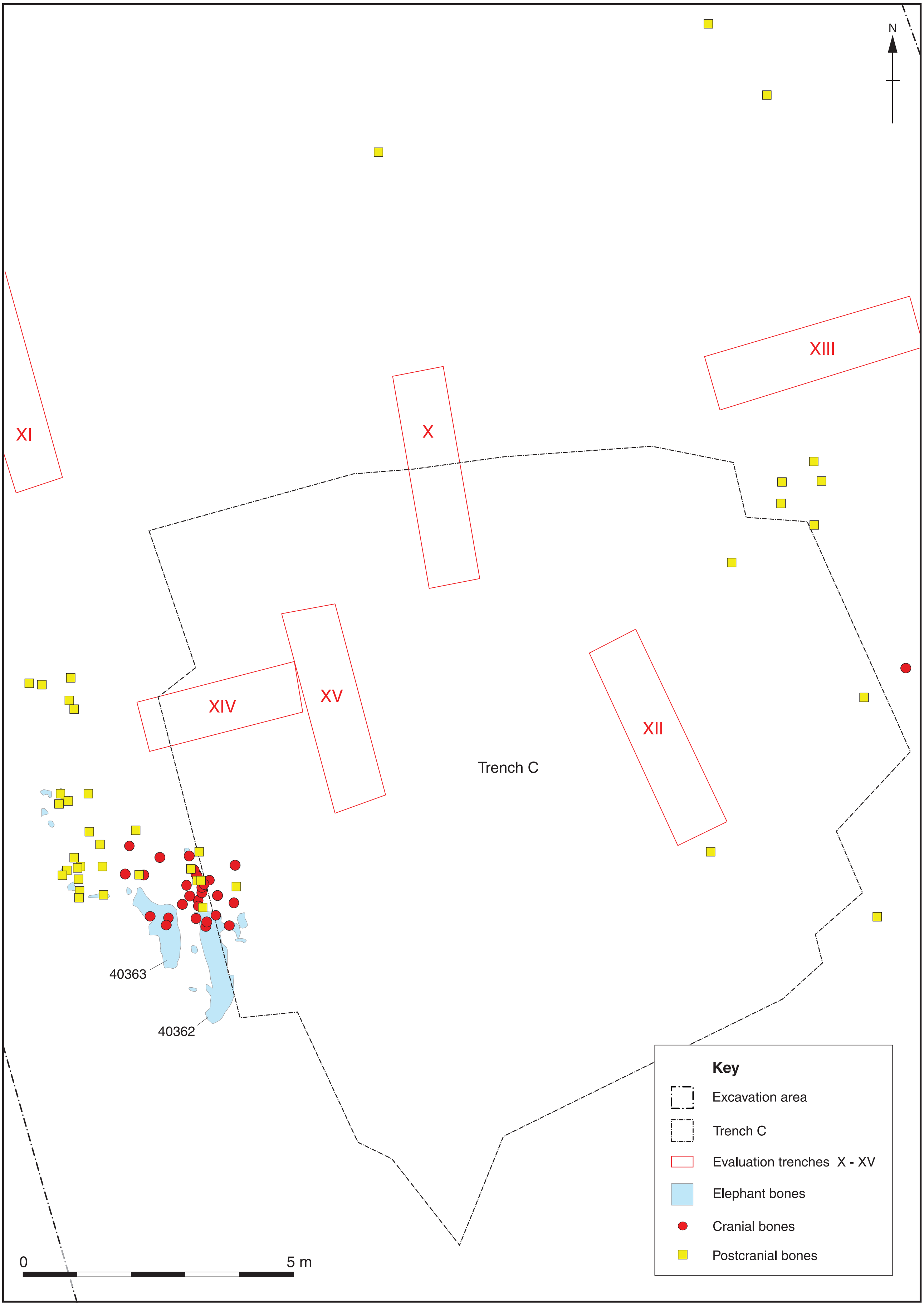


Figure 8.13 Plan of elephant bones, showing the distribution of cranial and postcranial elements

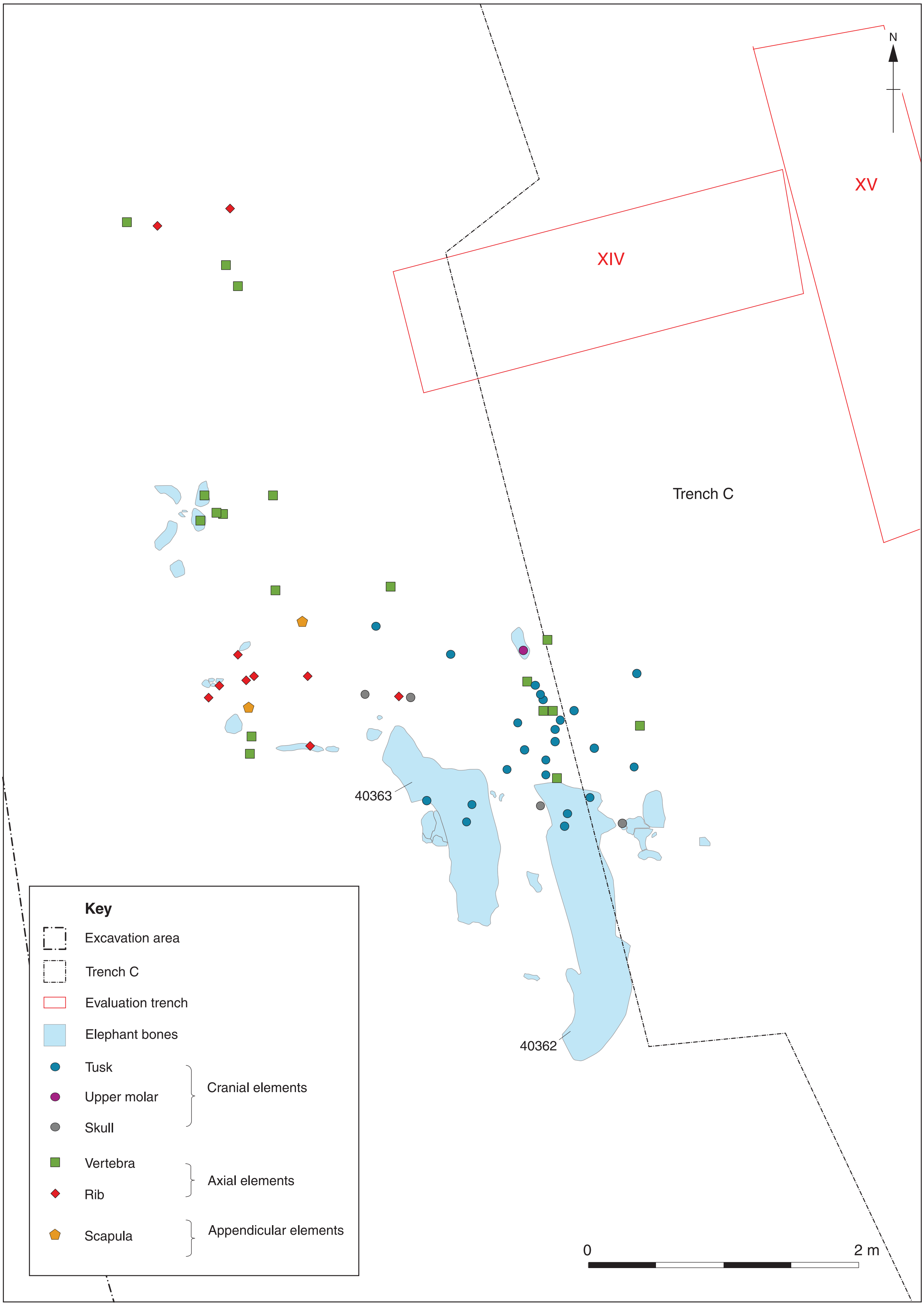


Figure 8.14 The main cluster of elephant bones, showing the distribution of bones according to body part

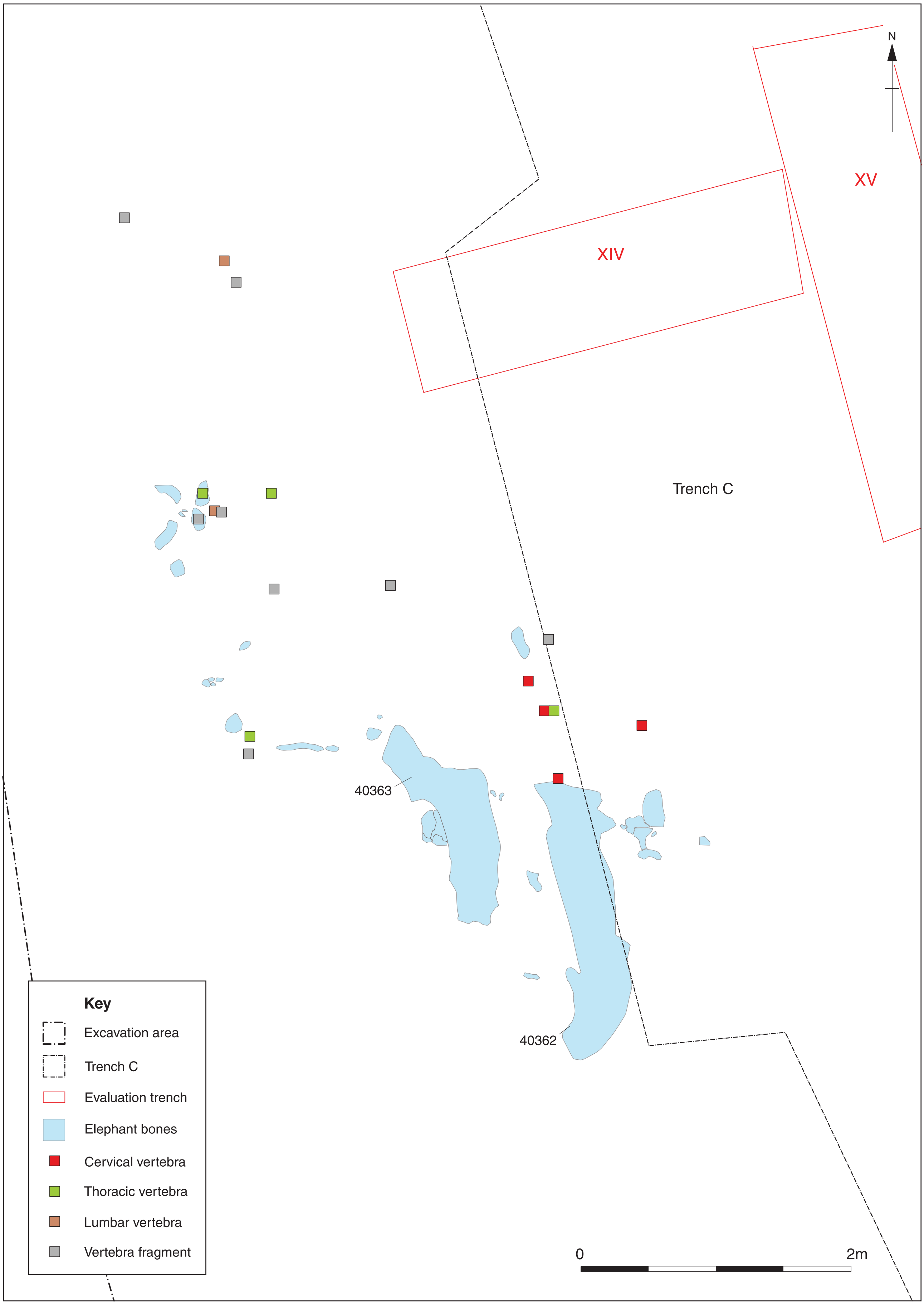


Figure 8.15 Distribution of vertebrae in the main cluster in relation to the tusks (Δ.40363, Δ.40362)

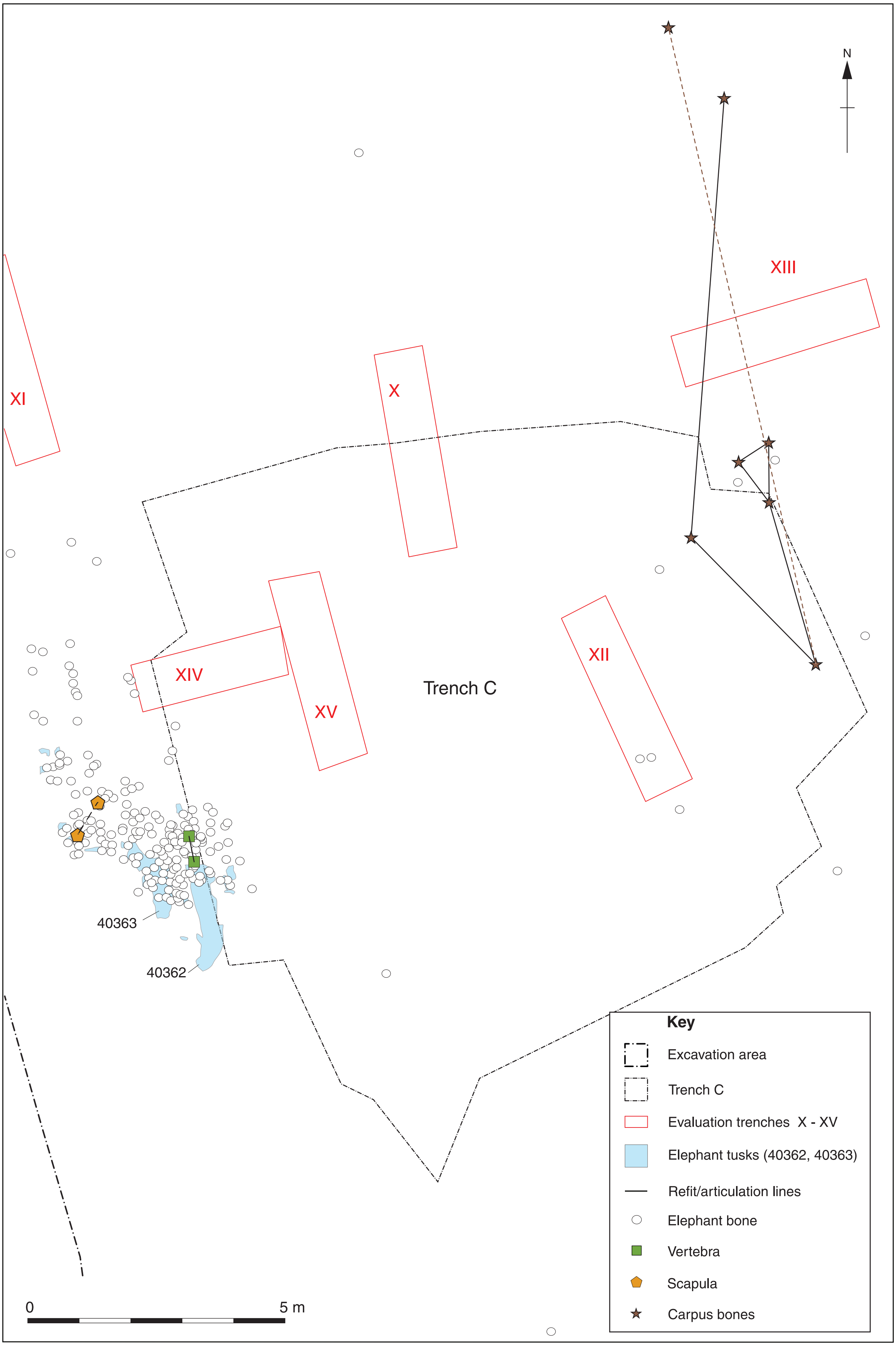


Figure 8.16 Distribution of refitting and articulating elephant bones at Southfleet Road

Larkin 2010), but not necessarily marked by carnivore chewing damage (see Haynes 1988, 139). At Southfleet Road, these bones are in an almost pristine condition, but nevertheless lack any evidence for tooth punctures or other chewing damage. The lack of any evidence for carnivore involvement suggests that the carcass was not heavily scavenged after death and that scavengers did not play a key significant role in dispersing the bones. Evidence for water transport of the bones is equivocal. Although the carcass site is located on the edge of a river valley next to a stream, there is no sedimentological evidence of high-energy water flow (eg channelling and bedded sediments). This is supported by the presence of elements with different transport properties (vertebrae, molars and tusks), which is inconsistent with sorting by fluvial processes (Frison and Todd 1986). Nevertheless, the long axis orientation of the elongated bone fragments does exhibit a clear preferred orientation (Fig. 8.17), with most of the bone long axis measurements falling between 40 and 120 from north (Fig. 8.12). The most parsimonious explanation is that these bones, which are mostly small pieces less than 50mm long, were aligned by slow-flowing water, possibly from sheet-flow during flooding events. The refit orientations of the articulating foot bones may indicate faster flowing water associated with the tufa channel. Here, the refit orientations are aligned parallel to the channel (Fig. 8.16), implying that stream flow was sufficient to entrain the foot bones and carry them in a north-south direction. The sequence of carcass decay and disarticulation observed in natural situations conforms to the distribution of elephant skeletal elements at Southfleet Road (Fig. 8.16), suggesting that natural processes alone could account for some aspects of the bone distribution and preservation patterns observed at the site.

Table 8.3 Summary of elephant bone fragment size

Element	*Fragment length*				
	<5cm	*6-10cm*	*11-20cm*	*21-30cm*	*>30cm*
Skull		3			1
Molar				1	1
Tusk	4	1	5	3	4
Vertebra		3	9	4	2
Rib			7	3	2
Scapula				1	1
Carpus bones			6	1	1
Indet.	17	75	49	8	3

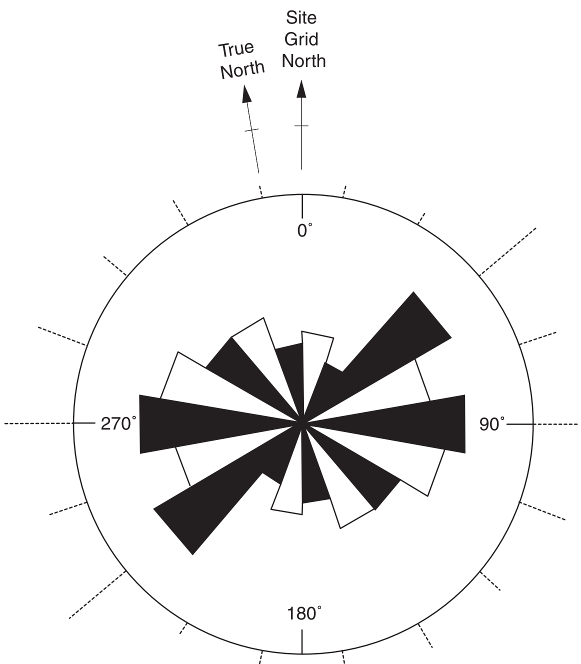


Figure 8.17 Orientations of elephant bone fragments from context 40078 plotted as a bidirectional rose diagram. The long axis orientations (measured from site plans) exhibit a strong preferred orientation

Most of the elephant bones from Southfleet Road are broken. A notable feature of this assemblage is the high degree of breakage reflected in fragment size distributions (Table 8.3). In the absence of any evidence for carnivore breakage or marrow fracture and other processing activities undertaken by humans, the breakage is likely to have been the result of weathering and trampling. Trampling by large mammals seems to have been an important agent of pre-depositional breakage. This is indicated by patches of sub-parallel, shallow scratch marks on several bones (Fig. 8.18); these are interpreted as trampling abrasions (cf. Andrews and Cook 1985; Behrensmeyer *et al.* 1986). It is likely that much of the breakage was due to trampling, but because the sediment is fine-grained, the trampling did not always leave visible surface marks. The fact that none of the bones were found lying at a steeply inclined angle suggests that the bones were trampled on a relatively hard substrate. The larger bones may also have been in a weakened condition as a result of prolonged exposure to weathering. This is suggested by the poorest preservation, which is observed in the largest fossils, for example the skull and tusks. These would have been exposed to longer periods of sub-aerial weathering than the smaller more easily buried bones that show little or no evidence for exposure (see above). Clearly, weathering could have been a contributory factor in the breakdown and destruction of thinner-walled bones, such as the skull, which probably disintegrated before sediments built up around them. Elephants may also have had a role in modifying the carcass by breaking and dispersing the bones. Living elephants react strongly to the carcasses of other elephants and there are numerous observations of modern African elephants revisiting sites of elephant skeletons and carrying and kicking bones around. These bones are often smashed and trampled underfoot during their investigations (Haynes 1991). There is no reason to believe that extinct relatives differed in their reaction to elephant carcasses and the actions of inquisitive straight-tusked elephants may provide an explanation for some of the patterns observed at Southfleet Road.

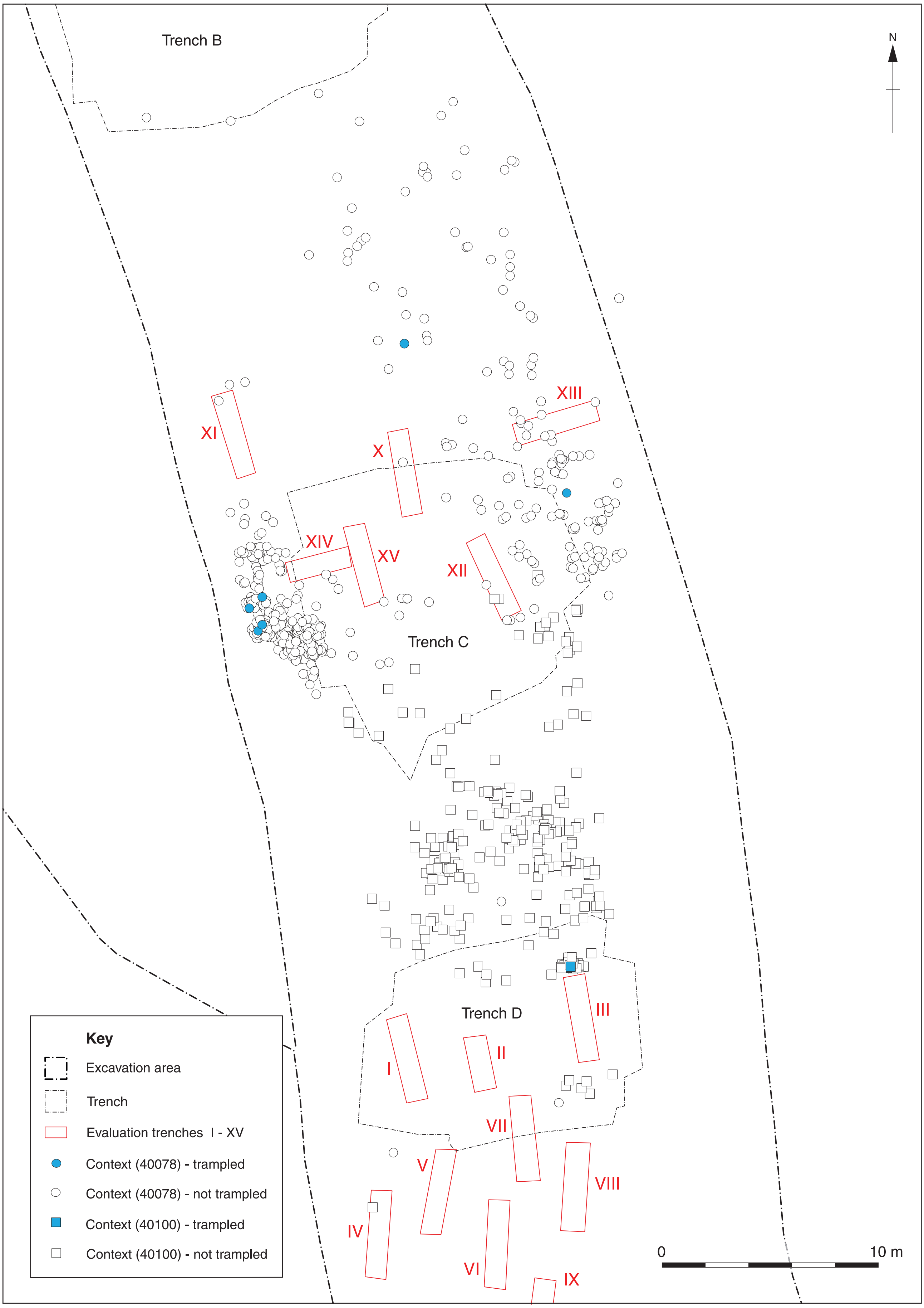


Figure 8.18 (a) Distribution of bones from contexts 40078 and 40100 with surface marks attributed to trampling by large mammals

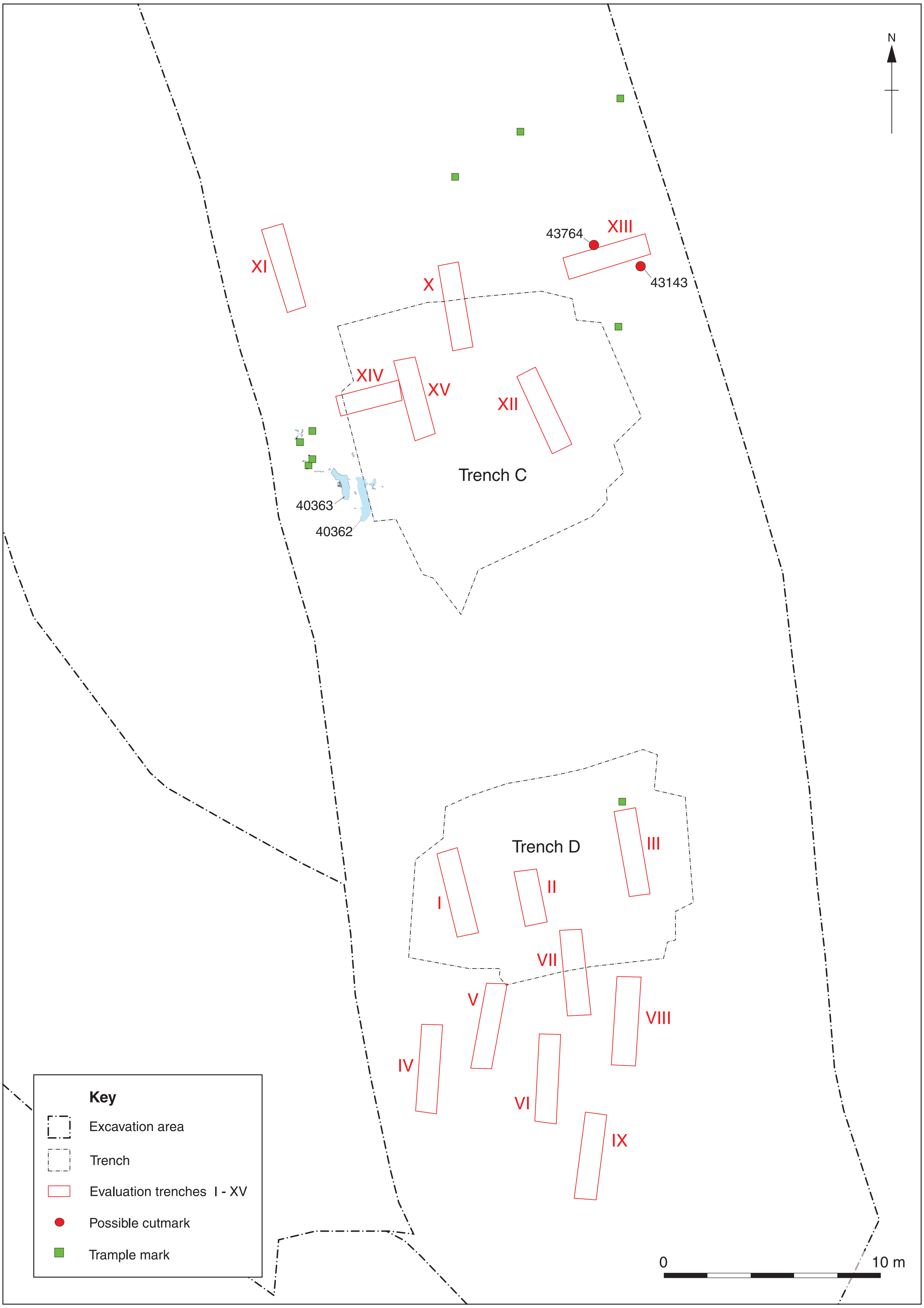


Figure 8.18 (b) Plan showing the location of cut-marked deer bones

Summary

Although less than 5% of the skeleton was recovered and many of the bones are poorly preserved, it has been possible to reconstruct a reasonably coherent picture of the environment in which the elephant lived and died and to infer aspects of its taphonomic history. Although many of the bones were fragmentary and difficult to identify, there appears to be no duplication of skeletal elements in the assemblage. Moreover, the size and ontogenetic age are conformable, supporting the interpretation that the teeth and bones in the main scatter belong to the same individual as the dispersed carpus bones. Wear on the third upper molars indicates that the elephant was about 45 years old at time of death, with no obvious skeletal pathology (Appendix D5). Size comparisons with more complete and better-preserved skeletons indicate that the Ebbsfleet elephant was an enormous animal, probably approaching 4m at the shoulder (based on comparison with the almost complete skeleton of similar size from Upnor, Andrews 1928) and probably weighing *c* 9 tonnes, making male gender very likely (Fig. 8.19). This is considerably larger than any modern African bull elephant, which typically weigh no more than 6 tonnes. The Ebbsfleet elephant is one of the largest straight-tusked elephant skeletons known, although not quite as large as the exceptional Gröbern I individual (Davies 2002). The carcass would have provided a huge source of food and raw materials had it been utilised by early humans.

Aspects of the mode of life of the straight-tusked elephant can be deduced from its skeletal and dental morphology, combined with floral and faunal evidence (Stuart 1982). In northern Europe, the straight-tusked elephant was strongly tied to temperate climates with wooded or mixed vegetation (Stuart 1982), but it is generally absent from intervening cold stage faunas (Lister 2004; Stuart 2005; Mol *et al.* 2007). It almost certainly fed on a mix of herbaceous vegetation and browse. These environmental and climatic associations are fully in keeping with the ecological and climatic context of the Ebbsfleet elephant, with associated environmental evidence suggesting a period of fully temperate climatic conditions and a mixture of open ground and deciduous woodland. The cause of death cannot be determined, but mortality of prime-aged bulls is an unusual event in the wild (Haynes 1991; Conybeare and Haynes 1984). Modern elephants are relatively invulnerable to predation (Haynes 1991) and large bull African elephants have no natural predators (other than man). The extremely large Ebbsfleet elephant is unlikely to have been troubled by lions, which were the largest predator in Britain at that time. There were no obvious bony pathologies, but many fatal diseases do affect the skeleton, and even hunting by humans and butchery may not leave any traces on the bones. One cause of death that can be safely excluded is miring in muddy sediments. Miring has been implicated in the death of the Aveley elephants from the intact foot bones found in anatomical position beneath the disarticulated bones. This contrasts with the situation at Southfleet Road, where the scattered carpus bones were dispersed from the primary carcass location.

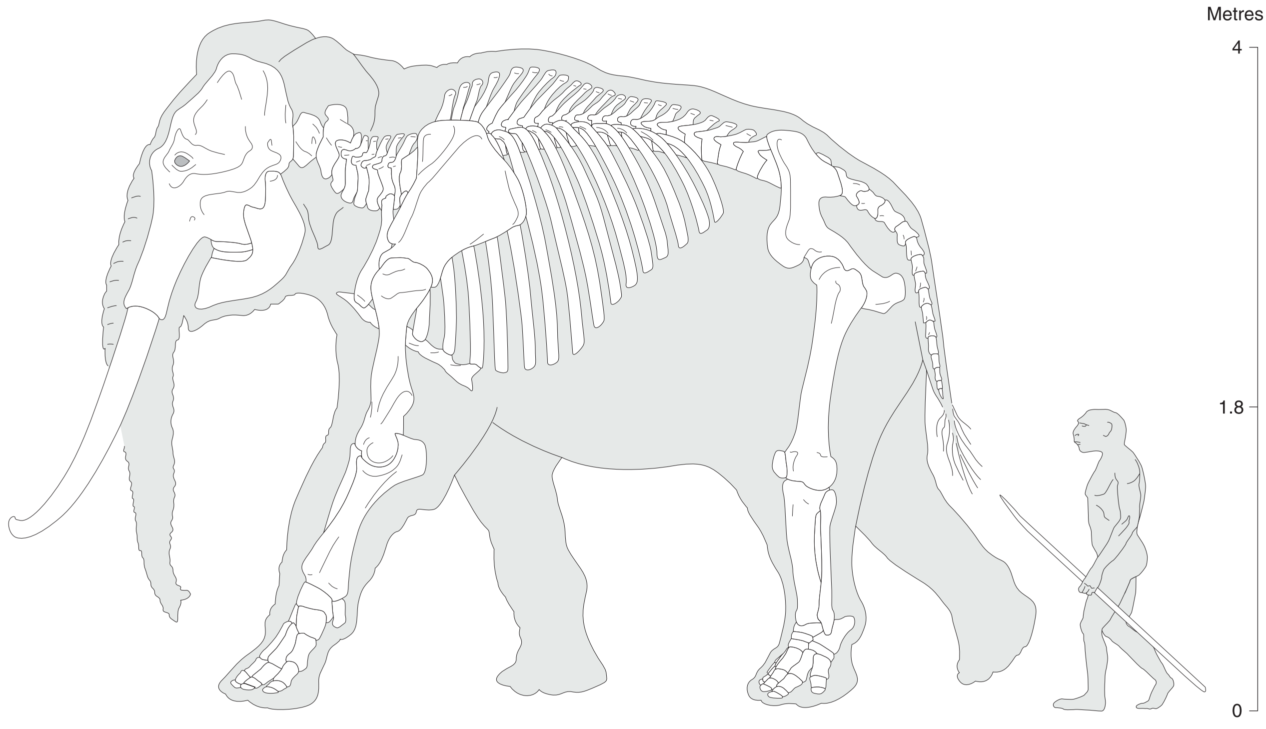


Figure 8.19 Reconstruction of the Ebbsfleet elephant (shoulder height of 4m), compared with estimated size of a Middle Pleistocene male hominin

The elephant appears to have died close to the edge of the valley in an alder carr swamp. The death site is represented by the main cluster of bones and this is where skeletonisation and primary disarticulation occurred. Although a wide range of skeletal elements from the axial skeleton is represented (cranium, tusks, upper molars, vertebrae and ribs), they are all from the anterior part of the animal and the only limb bone represented is the scapula. Missing elements include the sacrum, caudal vertebrae and the hind limbs. These parts of the skeleton were probably destroyed during road construction, which cut through the area of greatest bone concentration. The general distribution of elements suggests the carcass was originally orientated north–south and lying on its left hand side. According to Haynes (1993), this is the 'normal' death posture in the wild.

Shortly after death the carcass would have bloated and started to decompose, initially by autolysis as stomach and intestinal acids and enzymes escaped into the body cavity, and then more-rapidly as putrefaction and maggot infestation took hold. Scavenging carnivores, such as bear, lion and wolf, would have been attracted to the carcass at this stage, although here is no direct evidence for carnivore action from marks on the bones. These processes could have reduced the carcass to a pile of bones in a matter of months, somewhat longer if the elephant had died during the winter, or if the hide had become desiccated during a hot dry summer (Coe 1978). Over time, the skeleton would have completely disarticulated and individual bones become scattered and broken. However, some of the bones were buried close to their original anatomical position, with a linear arrangement of the vertebra and most of the rib fragments located behind the tusks. This suggests that an initial phase of bone breakage occurred shortly after the muscles, ligaments and tendons had decomposed and that some of the smaller bone fragments were buried rather rapidly. The bones in the main scatter also appear to have been inundated by flowing water, possibly at times of high-flood or as sheet-wash from torrential rainfall. This has aligned some of the smaller bones, but the water did not have sufficient power to cut channels, let alone transport the larger bones.

Because of their large size, some of the elephant bones would have remained unburied for many years and exposed to the destructive actions of weathering, lichen and microbial attack and trampling. Weathering is likely to have been the main destructive process. Numerous studies have shown that weathering is capable of reducing robust elephant bones into fragile, exfoliated and unidentifiable splinters (Haynes 1991). Elephants visiting the skeleton may also have contributed to the dispersal of the bones. There are numerous observations of African elephants displacing or rearranging or carrying such bones considerable distances from the carcass sites (Haynes 1991; Stuart and Larkin 2010). Elephants are also implicated in bone breakage, through trampling or by smashing the bones. Evidence for trampling at Southfleet Road is from abrasion marks on the elephant bones, which are typical of surface damage from large mammal trampling (Andrews and Cook 1985; Behrensmeyer *et al.* 1986; Haynes 1988).

Trampling, kicking and scuffing may also account for the diffuse scatter of rib fragments, the tip of a tusk and numerous unidentifiable elephant bone splinters found to the north and east of the main cluster. The diffuse scatter includes the articulating bones from the right carpus. Observation of modern elephant carcass disarticulation has shown that the foot bones are invariably amongst the first elements of the skeleton to separate from the carcass (Hill and Behrensmeyer 1984) and to be scattered and removed by carnivores (Haynes 1988). Chewing of the thin-walled spongy foot bones can result in puncture marks, grooves and breakage (Stuart and Larkin 2010), although Haynes (1988) has observed that in modern situations these bones 'rarely show signs of carnivore gnaw damage (ibid., 139). The foot of the Ebbsfleet elephant was probably dragged away from the carcass by large carnivores. Subsequently, the foot bones separated when the tissues connecting the bones decayed. The disarticulated bones were then dispersed by flowing water. Unlike many of the elephant bones in the main scatter, the foot bones are not crushed and deformed. The better preservation was probably due to their burial in calcium carbonate-rich sediments close to the edge of the tufa channel. Although the foot bones are well preserved, most of the bones in the main cluster were in poor condition. This is largely the result of unfavourable burial conditions. Geological evidence indicates compaction and down-slope sliding of the sediments containing the bones. The sediments are also leached and decalcified. These processes have combined to weaken the bones *in situ*. Finally, wetting and drying of the clayey matrix contributed to the poor condition of the bone with the repeating cycles of expansion and contraction of the sediments leading to internal cracking and fracturing.

The Ebbsfleet elephant makes an interesting point of comparison with the four other more-or-less complete straight-tusked elephant skeletons currently known from the British Pleistocene. The youngest of these is from Last Interglacial deposits at Deeping St. James, Lincolnshire (Davies 2002). The majority of this skeleton is missing and the foot bones chewed by spotted hyaena. It entirely lacks any associated artefactual remains. The famous 'Upnor Elephant' skeleton was found in 1911 in fluvial deposits of the River Medway in Kent (Andrews 1928). This skeleton, which is largely complete, was mounted for museum display without the skull, since it was too fragile to conserve. The skeleton represents an extremely large male and dates to the late Middle Pleistocene. As with the former specimen, it entirely lacks archaeological associations. Bones of several individuals have been recovered from late Middle Pleistocene (MIS 7) deposits at Sandy Lane Pit in the Lower Thames Valley at Aveley. The most complete skeleton was excavated by palaeontologists from the British Museum (Natural History) from beneath a mammoth skeleton (Bridgland 1994; Sutcliffe 1995). The presence of two elephants buried in clays and silts close to the margin of a river channel suggests that they had become mired in the soft channel sediments having fallen down the steep and slippery bank of London Clay (Bridgland 1994; Sutcliffe 1995; Davies 2002). There are anecdotal records of lithic material being found in the vicinity (M. J. White, pers. comm.), but there are no provenance records confirming the exact locations and context of the surviving flint artefacts. At Selsey, West Sussex, a partial skeleton of straight-tusked elephant has been excavated from interglacial channel deposits under the beach. A few flint artefacts were recovered in association with the Selsey skeleton. These comprise one small proto-Levallois core, one flake and a piece of irregular waste. As with the Ebbsfleet elephant, no traces of butchery have been observed on the Selsey elephant bones.

MICROSCOPIC EXAMINATION OF CUT MARKS AND TROWEL DAMAGE ON LARGE MAMMAL BONES

by Silvia M. Bello and Simon A. Parfitt

All of the large mammal bones and teeth were scanned for cut and percussion marks using a variable-magnification binocular microscope under low-angle illumination. No unequivocal evidence for marrow processing was found, but two deer bones have linear incisions that are attributed to cuts made during defleshing and disarticulation.

The identification of cut marks is not always straightforward as natural taphonomic processes, such as sediment abrasion and trampling, can create marks on bones that closely resemble cuts, chops and scrapes produced during butchery with stone tools (Shipman 1981; Behrensmeyer *et al*. 1986; Boulestin 1999; Domínguez-Rodrigo *et al*. 2009). In most cases, however, it is possible to identify butchery marks from microscopic features (Shipman and Rose 1983b; Bromage and Boyde 1984; Blumenschine and Selvaggio 1988; Villa and Mahieu 1991; Greenfield 1999; Pickering and Hensley-Marschand 2008) and anatomical position (Binford 1981). Butchery of large mammal carcasses usually involves skinning, disarticulation, defleshing and marrow extraction, with each process leaving a characteristic pattern of marks on the bones, linked to cutting of ligaments and tendons (disarticulation), muscle attachments (defleshing) and skinning and impact damage from marrow bone breakage (Binford 1981). The bone-bearing sediments at Southfleet Road are predominantly fine-grained and natural abrasion is uncommon (see observations on trample marks on elephant bones). More common are grooves, scratches and scrapes inflicted on the bones by metal tools during the excavation. Although the bones were excavated with great care, damage was unavoidable due to the fragile condition of the bones and the hardened clayey matrix in which they were buried. Trowel marks were nevertheless easily to recognise under the binocular microscope as they were generally lighter in colour than the surrounding bone.

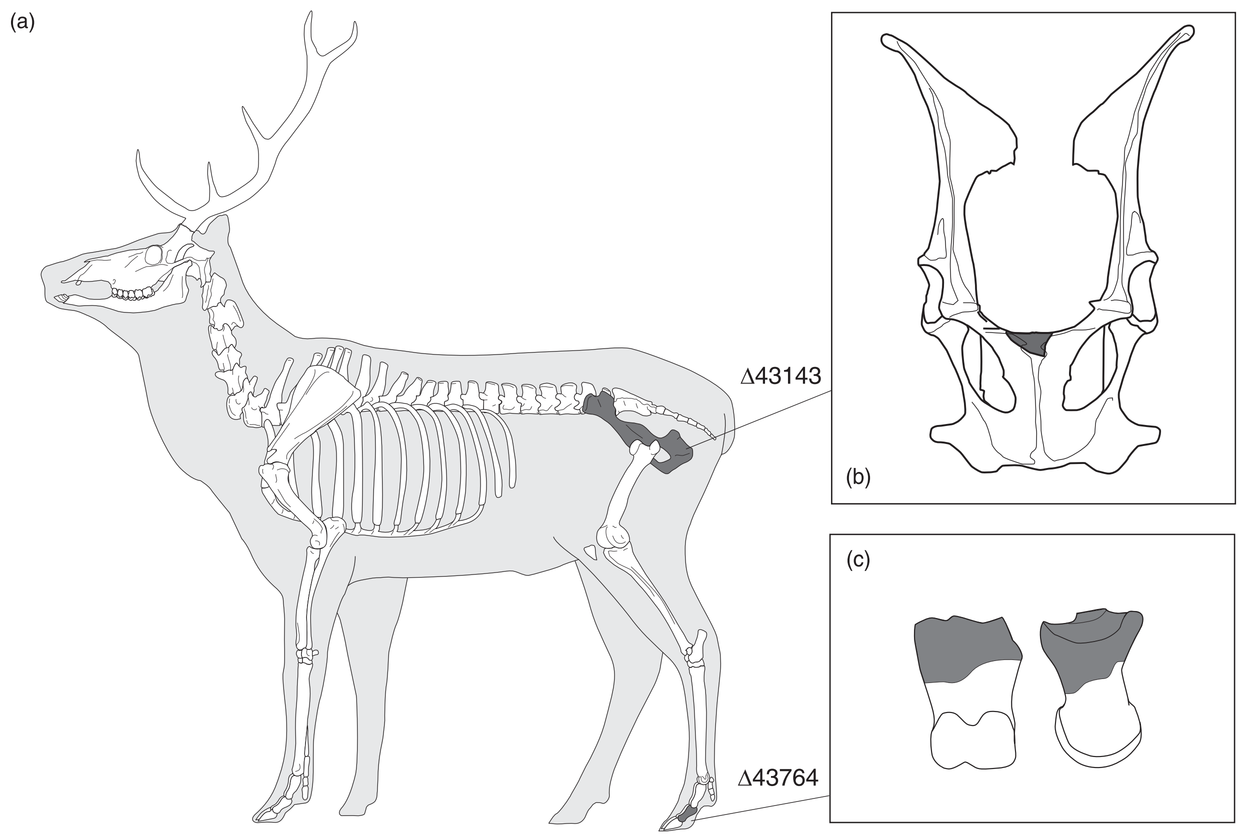


Figure 8.20 Anatomical position of deer remains with probable cut marks

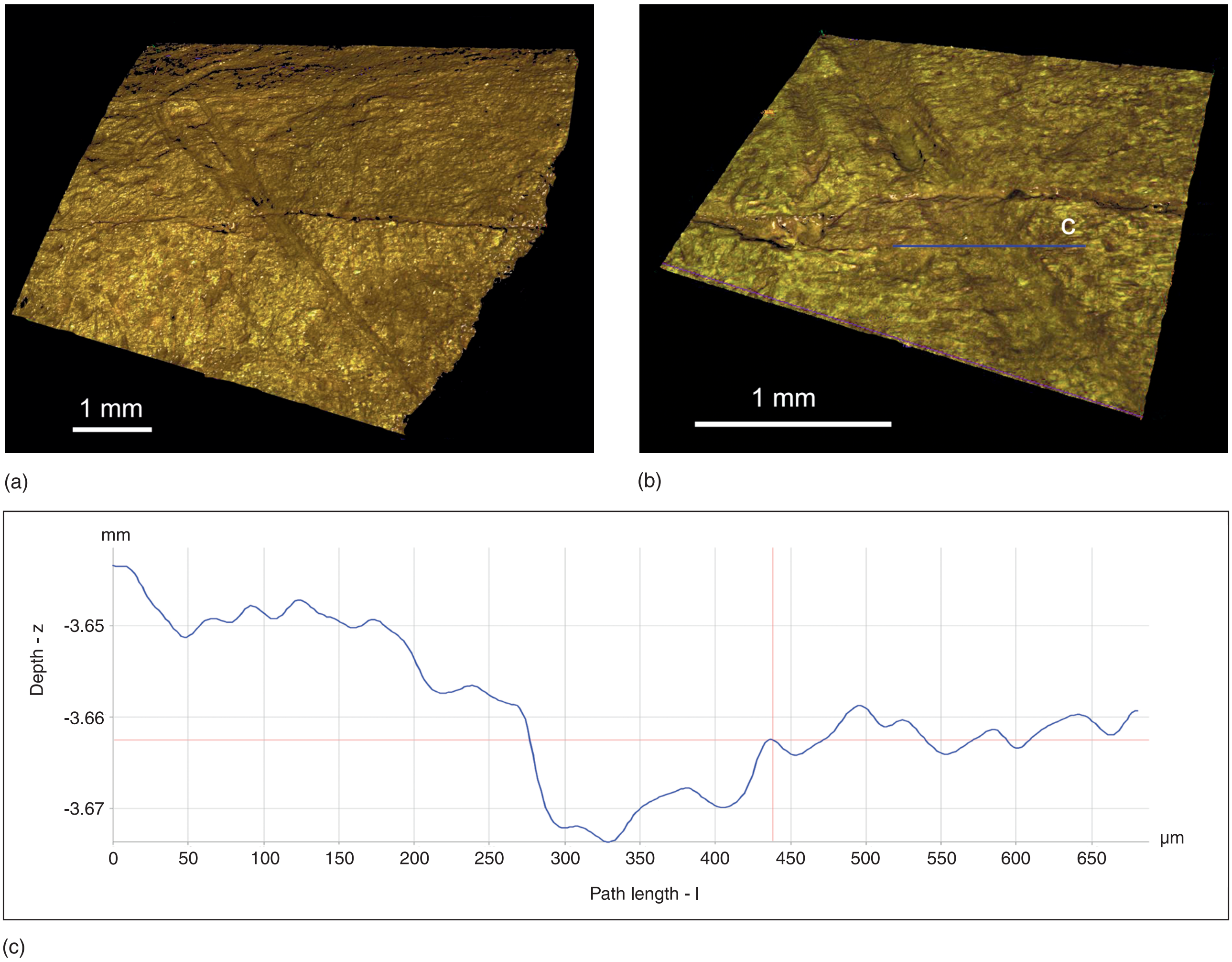


Figure 8.21 Cut mark on the pubis of a medium-sized deer (Δ.43143): (a) oblique view Alicona image of probable cut mark. Note probable 'shoulder effect' (magnification 2.5x, vertical resolution 9.46µm, lateral resolution 19.50µm); (b) close-up of the incision (magnification 10x, vertical resolution 407nm, lateral resolution 1.46µm), showing internal microstriations; (c) cross-sectional profile at the mid-point of the cut mark. Note internal microstriations and asymmetric V-shaped cross-section

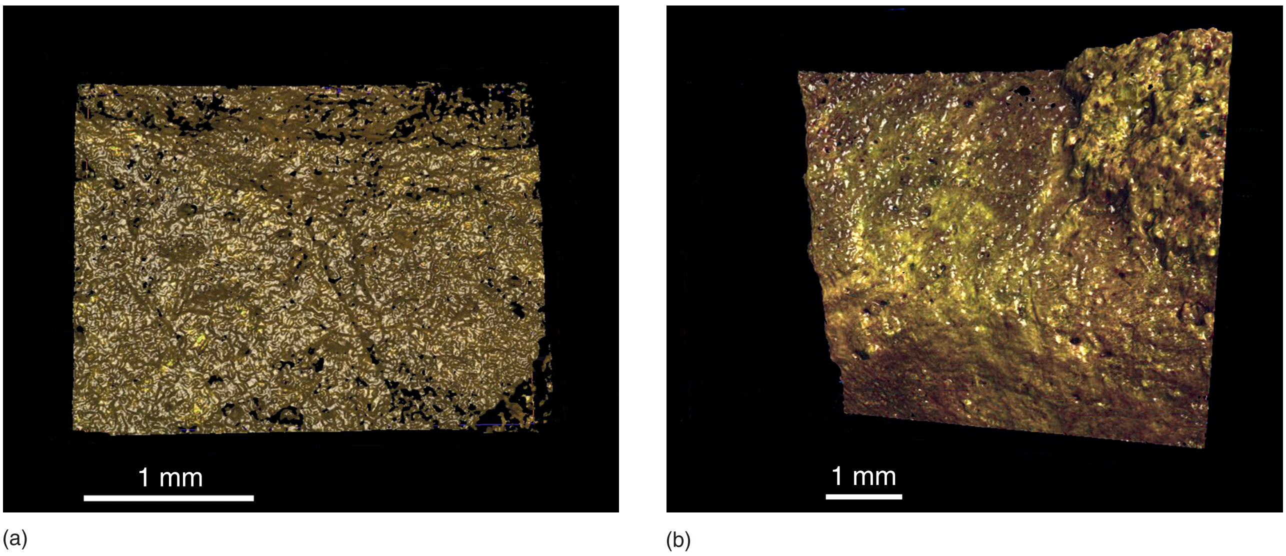


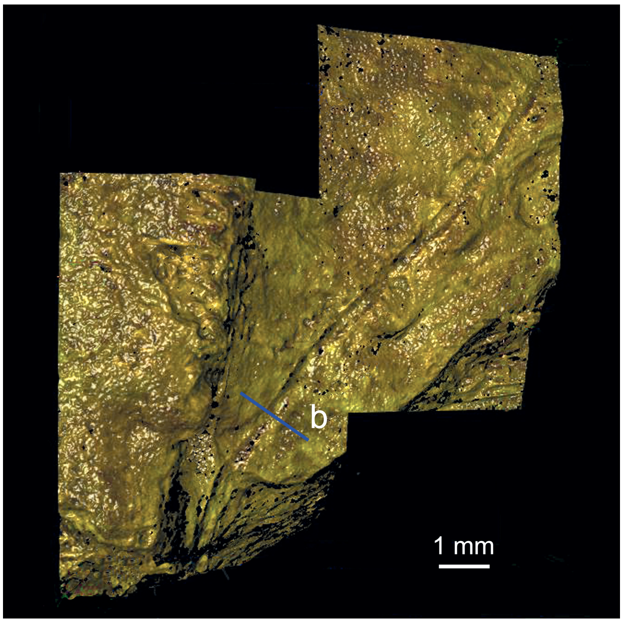
Figure 8.22 Probable cut marks on the phalanx of a medium-sized deer (Δ.43764). Oblique Alicona image of incisions: (a) first cluster of incisions (magnification 5x, vertical resolution 1.64µm, lateral resolution 7.82µm); (b) second cluster of incisions (magnification 2.5x, vertical resolution 9.46µm, lateral resolution 19.50µm)

Five bones were selected for more detailed microscopic study using an Alicona InfiniteFocus (AIFM) variation focus microscope. The AIFM is an optical microscope that integrates multiple scans to create a true-colour, three-dimensional surface model of an object. These images can then be manipulated to measure surface features (Bello *et al.* 2009; Bello 2011; see Bello and Soligo 2008 for methodology applied to measuring cut marks).

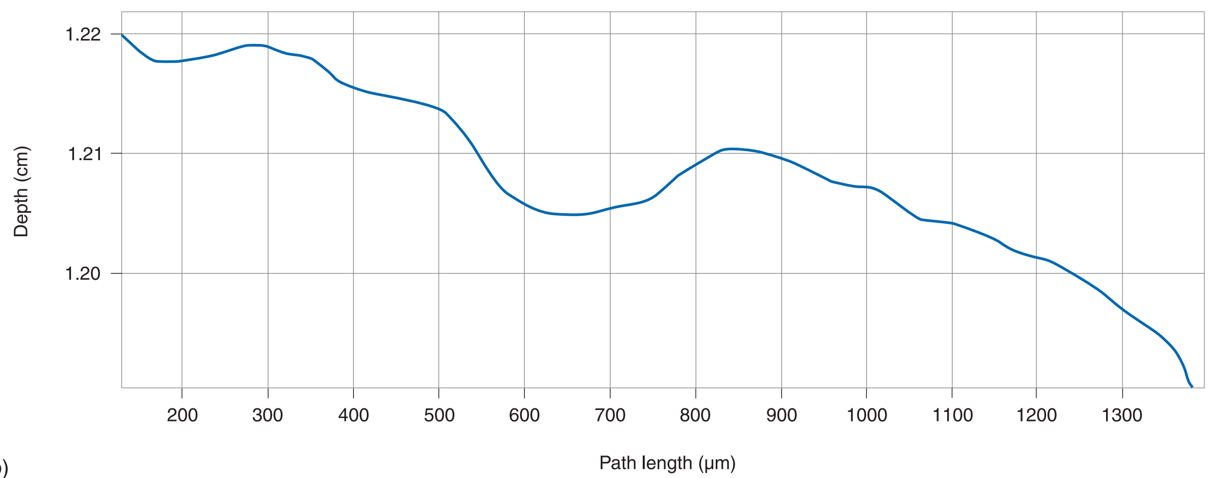
Two bones have fine incisions that are interpreted as slicing marks made during butchery (Figs 8.18; 8.20). Specimen Δ.43143 (40070) consists of the symphyseal part of the pubis of a medium sized deer. (Fig. 8.20a-b). The bone surface is well preserved and the dorsal face is marked with an isolated linear incision orientated along the cranial-caudal axis. Also apparent from the Alicona images is a second parallel, but much shorter, incision interpreted as 'shoulder effect'. Measurements taken at three points along main incision gave an average width of 124μm and the average depth 1μm. The measurements, presence of microscopic internal striations, and a possible shoulder effect, are consistent with a shallow cut mark (Andrews and Cook 1985; Behrensmeyer *et al.* 1986; Bello and Soligo 2008; Boulestin 1999; Domínguez-Rodrigo *et al.* 2009; Greenfield 1999; Shipman 1981; White 1992; Fig. 8.21a-b). The cross-sectional profile also resembles that of slicing-marks made with a stone tool (Fig. 8.21). The location and orientation of the cut mark indicates filleting or evisceration.

The second cut specimen (Δ.43764, context 40039/70) is the proximal half of a second phalanx of a medium sized deer (Fig. 8.20a and c). Macroscopically, the surface appears to be well preserved, with no obvious signs of weathering, trampling or post-depositional corrosion, but the breakage appears to have occurred during excavation. Two distinct clusters of striations were observed on the palmar surface. The first group consists of two short incisions, both with oblique orientations to the anatomical axis of the bone; the other group of two incisions has a perpendicular orientation with respect to the main axis (Fig. 8.22a and b). None of the incisions exhibits clear diagnostic features which would discriminate between trampling marks (Andrews and Cook 1985, Behrensmeyer *et al.* 1986; Domínguez-Rodrigo *et al.* 2009) and humanly induced butchery-marks. It may be significant that the average width (125μm) and depth (16μm) of these marks is compatible with equivalent dimensions of specimen Δ.43143. Although the microscopic morphology of the marks is difficult to interpret, their location is suggestive of human-derived butchery marks. Similar marks can be observed in butchered archaeological assemblages and in experimental butchery from skinning or cutting of tendons that hold the foot together.

Three bones (Δ. 40784, 40689, 41828) were selected to illustrate the morphology of grooves made accidentally with metal tools (trowels) during excavation and on-site cleaning of the bones (Figs 8.23-25).



(a)



(b)

Figure 8.23 ?Elephant bone splinter (Δ.40784) with trowel mark. Oblique Alicona image (magnification 2.5x, vertical resolution 9.46μm, lateral resolution 19.50μm); (b) cross-sectional profile

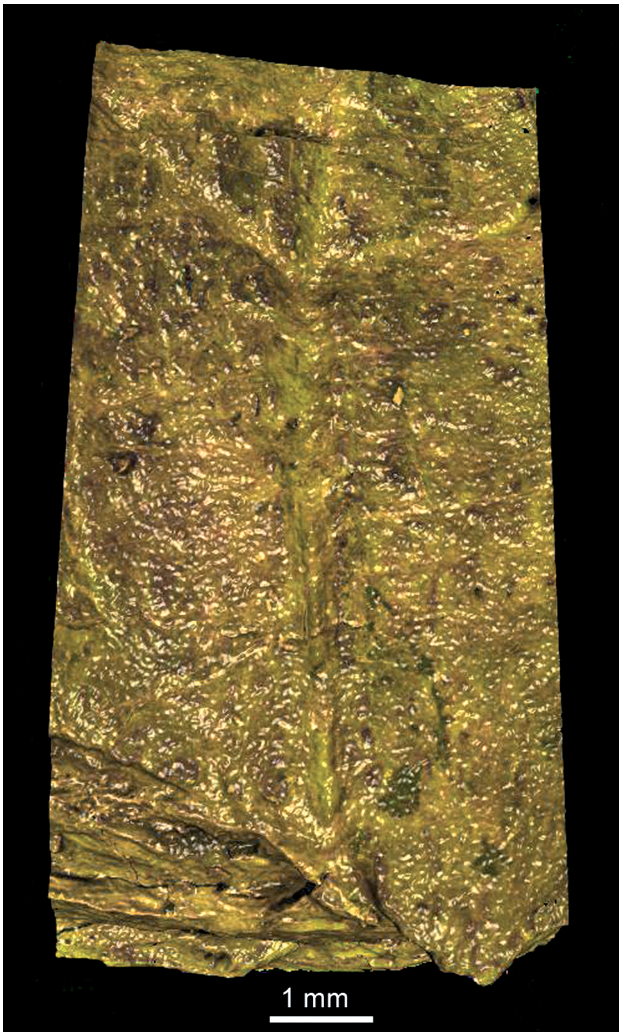


Figure 8.24 Oblique Alicona image of groove on ?Elephant bone splinter (Δ.40689), showing typical features of a trowel mark (magnification 2.5x, vertical resolution 9.46μm, lateral resolution 19.50μm)

Although some bear a superficial resemblance to butchery cut marks, the trowel marks are usually lighter in colour than the surrounding cortical bone. Another indication that they were inflicted during the excavation is apparent because they cut-across, or 'smudged' manganese deposits and sediment adhering to the surface of the bone. Microscopically, they have smooth rounded profiles and open cracks or micro-faults perpendicular to the long-axis of the groove; they are typically longer and wider than cut marks. Specimen Δ.40784 (40070) is an indeterminate bone fragment, probably from an elephant. The bone is marked by an isolated long sinuous groove, which extends onto the broken edge of the fragment (Fig. 8.23a). Width and depth measurements were taken at four points along the groove and gave an average width of 377μm and an average depth of 64μm. The smooth U-shape cross-sectional is readily apparent in the AIFM profile (Fig. 8.3b). The second bone with excavator-damage (Δ.40689) is an indeterminate bone fragment that, because of its cortical thickness, is also likely to be from an elephant. The groove (Fig. 8.24) is similar in morphology to the previous mark, although it is somewhat broader (average measured at three points = 548.7μm) and deeper (average measured at three points = 103.9μm). The final piece is a fragment of large mammal bone (specimen 41828) which is impossible to identify either to element or taxon. There is a single relatively long curved groove (Fig. 8.25a). Although this feature is much narrower (average width measured at four points = 149.2μm) and shallower (average depth measured at four points = 10μm) than the other trowel marks, it is identical in having a smooth U-shaped profile (Fig. 8.25b).

DISCUSSION AND CONCLUSIONS

Southfleet Road is a rare Lower Palaeolithic example of a site with a single elephant skeleton found in association with an isolated scatter of *in situ* stone tools. Careful

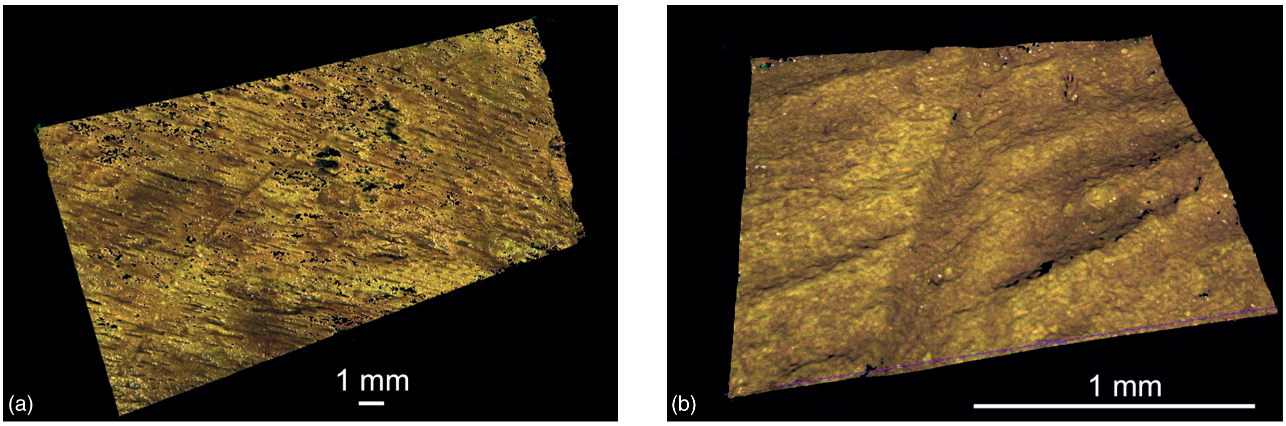


Figure 8.25 Indeterminate large mammal bone (Δ.41828) with trowel mark: (a) oblique Alicona images of the curved groove (magnification 2.5x, vertical resolution 9.46μm, lateral resolution 19.50μm) and (b) enlargement (magnification 10x, vertical resolution 407nm, lateral resolution 1.46μm), showing featureless U-shaped profile

study of the bones, however, has failed to identify any unequivocal evidence for modification of the elephant bones resulting from butchery or marrow extraction. This does not rule-out processing of the carcass by early humans, because not all butchering activities leave traces on bones (Haynes 1991). Beyond the concentration by the elephant skeleton, lithic artefacts are scattered at a low density throughout the Phase 6 deposits containing the other large mammal remains, without any apparent co-association of faunal and lithic remains. They are abundant in the lithic concentration south of Trench D, where however few faunal remains were found – although this is thought to be due to preservational issues rather than an archaeological pattern. Direct evidence for lithic use for large mammal butchery is, however, tenuous and based on only two probable cut-marked deer bones. In this respect Southfleet Road is comparable to many European Lower Palaeolithic sites where there is little or no evidence for human involvement in the accumulation and modification of associated large mammal remains (Gaudzinski 1999; Gaudzinski-Windheuser and Turner 1999). Whether this is an indication of minimal human involvement in the accumulation of the bones is unclear as detailed taphonomic analyses have not been undertaken at key sites (but see Gaudzinski-Windheuser *et al.*, 2010). At the Upper Palaeolithic-Mesolithic site of Three Ways Wharf (Uxbridge, UK), poor preservation of bones was implicated in the difficulty in recognising cut marks and other butchery evidence (Lewis and Rackham 2010). Although this site has yielded several thousand large mammal bones from open-air hunting camps, less than a dozen bones exhibit convincing cut marks, and no impact features were identified. This highlights the fact that cut marks made with stone tools are generally superficial features that can be obliterated by even minor weathering, flaking and abrasion of the bone surface. Cut marks and other impact features are also susceptible to post-depositional weathering and soil corrosion, which may erode microscopic features thus rendering analyses difficult. The generally poor state of preservation of the Southfleet bones must therefore be taken into account when considering the scant evidence for large mammal butchery at the site.

Other Clactonian sites with butchered faunal remains include Swanscombe (Phase I deposits), Clacton-on-Sea, Essex and Barnham, Norfolk (Parfitt 1998b). At the last site, the assemblage of large mammal bones is not particularly extensive, but does include a bovid femur shaft fragment with cuts and impact damage. Many more butchered bones are present in various collections from Clacton (Parfitt unpublished), but these often lack precise contextual information and the material recovered from archaeological excavations has yet to be studied in detail. Binford (1985) concluded that the Clactonian industry at Swanscombe, Kent, was associated with marginal scavenging of carnivore-ravaged carcasses for bone marrow. However, a re-analysis of butchered large mammal bones identified by Binford (ibid.) has established that the alterations in the Swanscombe sample include both natural and excavation damage. Preliminary study of the cut marks on the Clacton and Swanscombe bones shows that they appear to relatively shallow and narrower than cuts made with handaxes. Although this observation has yet to tested with measurements (cf Bello *et al.* 2009), the shallowness of the cut-marks together with poor preservation of bones surfaces, may account for problems encountered with recognising and interpreting Clactonian butchery practices.

Establishing whether elephants were hunted and butchered during the Lower and Middle Palaeolithic periods is a particularly difficult problem (Clark and Haynes 1970; Shipman and Rose 1983a; Scott 1986; Jones and Vincent 1986; Binford 1987; Villa 1990; Piperno and Tagliacozzo 2001; Mazza *et al.* 2006; Mussi and Villa 2008; Waters *et al.* 2011; Slimak *et al.* 2011; Schreve 2006 vs Smith 2012). Some authors have suggested that early humans undertook planned hunting of elephants using thrusting or throwing spears (Weber 2000), whereas other studies have invoked scavenging at death sites (Binford 1987; Anzidei *et al.* 2012). More marginal utilisation may have involved the exploitation of bones to make handaxes and other cutting tools (Gaudzinski *et al.* 2005; Boschian and Saccà 2009). Other studies have suggested that associations between Proboscidean bones, even when found as an isolated skeleton, and stone tools can be entirely fortuitous (Byers 2002). Consideration of hominin involvement with megafaunal, and particularly Proboscidean, remains must take account of results from modern elephant butchery experiments, which have shown that it is possible to strip meat from the carcass without marking the bones (Frison 1989; Frison and Todd 1986; Haynes 1991). Elephant bones are unusual in that the diaphyses are encased in thick perisoteum and articular surfaces have a thick layer of cartilage, both of which protect the bones from accidental contact with cutting tools. The sheer quantity of potentially edible tissue on an elephant carcass may also be an important factor that could have resulted in only limited butchery. This may have involved partial skinning and filleting to gain access to largest muscle blocks or removal of the internal organs. Palaeolithic evidence for partial exploitation of a carcass may include the butchered elephant skull from Gesher Benot Ya'aqov, Israel (Goren-Inbar *et al.* 1994), where cut marks indicate the removal of the trunk, and breakage of the skull has been implicated in the removal of the brain. Another example of partial exploitation may have taken place at Áridos 2, Spain (Yravedra *et al.* 2010). Here, cut marks are found on the ventral surfaces of the ribs indicating evisceration and removal of internal organs, which can only have occurred shortly after death and before scavenging carnivores had attacked the carcass (Yravedra *et al.* 2012). Another important factor determining the extent of human utilisation of elephant carcasses was the speed of soft-tissue decay and the loss of edible tissue to scavengers. Although carcasses may have remained in an edible condition for several months during winters in northern latitudes (or even longer in the permafrost zone), those in the tropics and temperate situations would have decayed rapidly through the action of microbes and maggots. This would have limited the opportunities for fully exploiting the carcass, making it less likely that bones were marked during butchery. There is also evidence for Palaeolithic evidence for the exploitation of elephant bones for oils and bone grease. As elephant bones do not have marrow cavities, the fat and grease contained within the spongy and cancellous bone can be extracted by hanging broken bones in the sun, or by heating and boiling. Although bone breakage suggestive of bone fat extraction has been recorded in Palaeolithic contexts (Yravedra *et al.* 2012), there is currently no evidence to suggest that bone grease extraction involved the use of fire.

Non-dietary utilisation of elephant carcasses could have taken place long after any edible tissue remained on the carcass. In areas where lithic raw materials are scarce, there is evidence that elephant bones were knapped to make cutting tools. Dried hides could have been used for a variety of purposes (eg ethnographic examples of foot pads used as bowls) and other useful soft tissues such as tendons would have been suitable for making bindings. In treeless landscapes, elephant bones with its high fat content may have provided the only reliable source of fuel. At La Cotte de St. Brelade, Jersey, the abundance of burned bones in the Middle Pleistocene cold stage levels has been suggested to indicate use of bones for fuel (Stringer 2006). Bones may also have been used to make simple structures or windbreaks. The archaeological signal for many of these activities would be extremely weak. The current consensus is that exploitation of elephants and other large mammals, such as rhino and hippos, was more than just a marginal practice before the Upper Palaeolithic (Yravedra *et al.* 2012).

Although there is no direct evidence from cut marks or impact damage to indicate that the Ebbsfleet elephant was butchered, the tight spatial association of lithic artefacts and elephant bones may be sufficient to justify the assumption. This is supported by the vertical distribution of the stone tools, which are found at the same level as the bones and by use-damage on some of the artefacts, which has been interpreted as resulting from their use as butchery tools (Chapter 17). Although the patterns in bone distribution and the taphonomic alterations observed on the Ebbsfleet elephant bones can be explained by natural (ie non-human) processes alone, the spatial associations and lithic use-wear evidence provide compelling evidence that the carcass was exploited by early humans (Chapter 22).