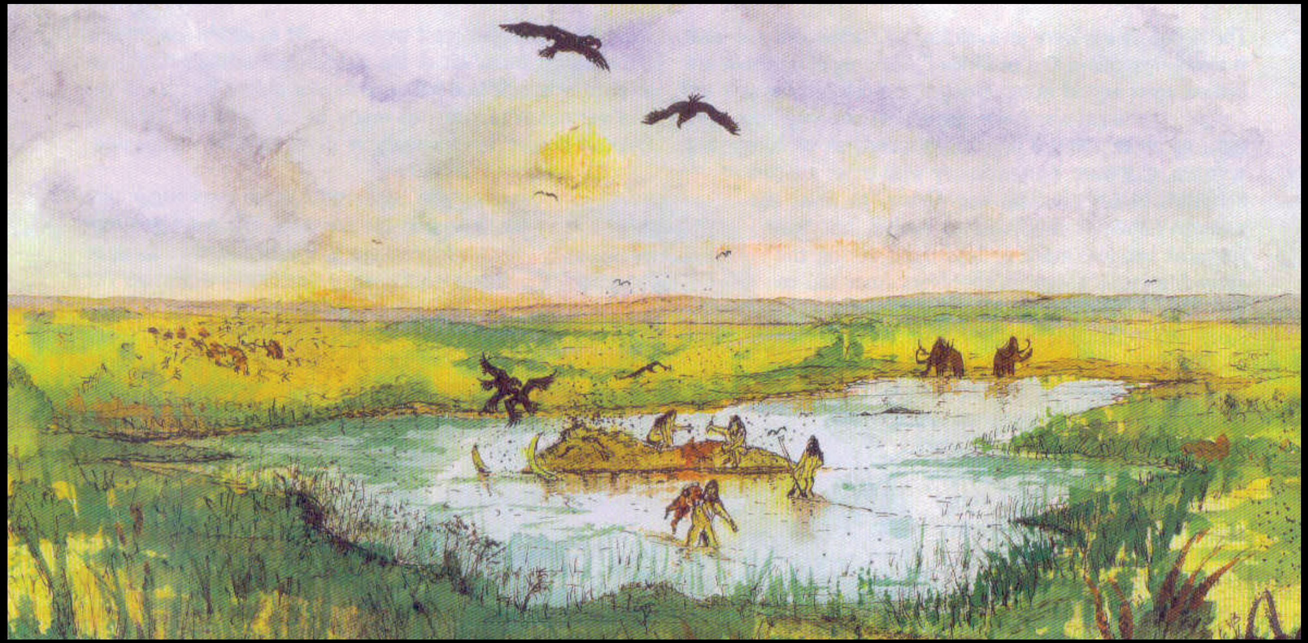

In spring 2002 mammoth bones and stone tools were discovered *in situ* at Lynford Quarry, near Munford village, Norfolk, UK. The finds lay within rich organic sediments of an ancient stream channel. It was immediately realised that Lynford was a site of great international significance for the study of the most distinctive of human ancestors, Neanderthals.

A detailed archaeological excavation was undertaken with support from Ayton Asphalte, the quarry owners, and English Heritage, funded through the Aggregates Levy Sustainability Fund (ALSF). A large team of archaeologists and quaternary scientists recovered exceptionally well-preserved Palaeolithic and palaeoenvironmental information. More than 1,000 mammoth bones representing at least 11 individuals were excavated along with other fauna and more than 2,500 stone artefacts. Among these the large number of complete and broken handaxes marks Lynford as special in the Palaeolithic of Britain and northern Europe. The quality of the preservation made it possible to undertake full investigation of the way the deposits had been formed and how the animal bones and stones tools had come to be incorporated in them.

The association of woolly mammoth bones with Middle Palaeolithic bifaces, including distinctive *bout coupé* handaxes, and the wealth of palaeoecological data – mammal remains, beetles, pollen and mollusca – make Lynford the most important British site for studying when and how Neanderthals occupied the cold, open environments of what 60,000 years ago was a peninsula of north-west Europe. These data provide a unique opportunity to investigate questions of Neanderthal hunting strategies and patterns of land use and to draw wider conclusions about their social structure in a demanding region of Ice Age Europe.

front cover: The first bout coupé *handaxe found at Lyndford and a lingual view of a* Mammuthus primigenius *third lower molar.*

back cover: Mammoths and Neanderthals at Lynford: a reconstruction by Dennis Payne.

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This volume is dedicated to

John Wymer and John Lord

for their contributions to Palaeolithic Archaeology
and the Prehistory of Norfolk

Neanderthals Among Mammoths

Excavations at Lynford Quarry, Norfolk

Edited by

William A Boismier, Clive Gamble and Fiona Coward

with contributions from

Julian Andrews, Stella Blockley, Don Brothwell, Matthew Collins, Russell Coope[†],
Francesco d'Errico, Randy Donahue, Laure Dubreuil, Adrian Evans, Michael Field,
Charlie French, Christopher Gleed-Owen, Frances Green, Vaughan Grimes,
David Keen[†], Nigel Larkin, Simon Lewis, Adrian Lister, Sonia O'Connor,
Kirsty Penkman, Richard Preece, Edward Rhodes, Michael Richards,
Danielle Schreve, Jean-Luc Schwenninger, Carol Simmonds,
Anthony Stuart, Keith Tovey and Mark White

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CONTRIBUTORS

Julian E Andrews, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK. Email: j.andrews@uea.ac.uk

Stella Blockley, Department of Geography, Royal Holloway University of London, Egham, Surrey TW20 0EX, UK. Email: stella.blockley@googlemail.com

William Boismier, Northamptonshire Archaeology, 2 Bolton House, Wootton Hall Park, Northampton, NN3 8BE, UK. Email: BBoismier@northamptonshire.gov.uk

D Brothwell, Department of Archaeology, The King’s Manor, York YO1 7EP, UK.

Matthew Collins, BioArch Biology, S Block, PO Box 373, York YO10 5YW, UK. Email: mc80@york.ac.uk

F Coward, Department of Geography, Royal Holloway University of London, Egham, Surrey TW20 0EX, UK. Email: Fiona.Coward@rhul.ac.uk

G Russell Coope[†], formerly of the School of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK.

Francesco d’Errico, CNRS UMR 5199 PACEA, Université Bordeaux 1, avenue des Facultés, F-33405 Talence, France. Email: f.derrico@ipgq.u-bordeaux1.fr

R E Donahue, School of Life Sciences, University of Bradford, Richmond Road, Bradford, West Yorkshire BD7 1DP, UK. Email: r.e.donahue@bradford.ac.uk

L Dubreuil, Department of Anthropology, Trent University, 1600 West Bank Drive, Peterborough K9J 7B8, Ontario, Canada. Email: lauredubreuil@trentu.ca

A A Evans, Archaeological, Geographical and Environmental Sciences, University of Bradford, Bradford, West Yorkshire BD7 1DP, UK. Email: A.A.Evans@bradford.ac.uk

M H Field, Faculty of Archaeology, Leiden University, PO Box 9515, 2300 RA Leiden, The Netherlands. Email: m.h.field@arch.leidenuniv.nl

Charlie French, Department of Archaeology, University of Cambridge, Downing Street, Cambridge CB2 3ER, UK. Email: caif2@cam.ac.uk

Clive Gamble, Faculty of Humanities (Archaeology), Building 65A, Avenue Campus, University of Southampton, Southampton SO17 1BF. Email: Clive.Gamble@soton.ac.uk

C Gleed-Owen, CGO Ecology Ltd, 5 Cranbourne House, 12 Knole Road, Bournemouth BH1 4DQ, UK. Email: chris@cgoecology.com

Frances Green, Sunnyside, Dilham Road, Worstead, North Walsham, Norfolk NR28 9RJ, UK. Email: fran.green@sunbeam.dircon.co.uk

Vaughan Grimes, Department of Archaeology, Memorial University, St. John's, Newfoundland A1C 5S7, Canada. Email: vgrimes@mun.ca

D Keen[†], formerly of the Department of Archaeology, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK

Nigel Larkin, Norfolk Museums and Archaeology Service, Shirehall, Market Avenue, Norwich, Norfolk NR1 3JQ, UK. Email: nrlarkin@easynet.co.uk

Simon G Lewis, Queen Mary University of London, University of London, Mile End Road, London E1 4NS, UK. Email: s.lewis@qmul.ac.uk

Adrian M Lister, Department of Palaeontology, The Natural History Museum, London SW7 5BD, UK. Email: a.lister@nhm.ac.uk

Sonia O’Connor, Archaeological Sciences, University of Bradford, Richmond Road, Bradford, West Yorkshire BD7 1DP, UK. Email: S.Oconnor@Bradford.ac.uk

Kirsty Penkman, BioArCh, Department of Chemistry, University of York, York YO10 5DD, UK. Email: kp9@york.ac.uk

R Preece, University Museum of Zoology, Downing Street, Cambridge CB2 3EJ, UK. Email: rcp1001@cam.ac.uk

E Rhodes, Environmental and Geographical Sciences, Manchester Metropolitan University, Chester Street, Manchester M1 5GD, UK. Email: e.rhodes@mmu.ac.uk

Michael Richards, Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, Leipzig, Germany D-04103. Email: richards@eva.mpg.de

Danielle C Schreve, Department of Geography, Royal Holloway University of London, Egham, Surrey TW20 0EX, UK. Email: Danielle.Schreve@rhul.ac.uk

Jean-Luc Schwenninger, Research Laboratory for Archaeology and the History of Art, Dyson Perrins Building, South Parks Road, Oxford OX1 3QY, UK. Email: jean-luc.schwenninger@rlaha.ox.ac.uk

Carol Simmonds, Northamptonshire Archaeology 2 Bolton House, Wootton Hall Park, Northampton NN3 8BE, UK. Email: CSimmonds@northamptonshire.gov.uk

A J Stuart, Biological and Biomedical Sciences, Durham University, South Road, Durham DH1 3LE, UK. Email: tony.s@megafauna.org.uk

N Keith Tovey, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK. Email: k.tovey@uea.ac.uk

Mark J White, Department of Archaeology, Durham University, Durham DH1 3LE, UK. Email: m.j.white@durham.ac.uk

SUMMARY

During an archaeological watching brief undertaken in the early spring of 2002 at Lynford Quarry, near the village of Munford in Norfolk, UK, John Lord uncovered the *in situ* remains of mammoth bones and associated Mousterian stone tools. These were contained within a palaeochannel rich in organic sediments. The importance of the site was immediately recognised, and with the support of Ayton Asphalte, the quarry owners, and English Heritage, an excavation took place between April and September of the same year funded through the Aggregates Levy Sustainability Fund.

The excavation recovered exceptionally well-preserved archaeological and palaeoenvironmental information. Such opportunities are extremely rare in the British Middle Palaeolithic when Neanderthals, making distinctive *bout coupé* handaxes (bifaces), intermittently occupied what was then a peninsula of north-west Europe. The association of many woolly mammoth bones, together with a wealth of palaeoenvironmental data, resulted in a unique opportunity to investigate questions of diet, land use and habitat from deposits within a small geological feature and subject the results to rigorous taphonomic and geoarchaeological scrutiny.

The organic silts and sands that fill the palaeochannel contain a cold-stage mammalian assemblage rich in mammoth remains, and an associated Mousterian flint industry. A series of optically stimulated luminescence (OSL) ages places the deposition of the main channel sediments in the interval *c* 65–57ka, at the transition between Marine Isotope Stages (MIS) 4 and 3. Studies of plant and invertebrate remains indicate open conditions dominated by grasses, sedges and low-growing herbaceous communities, with small stands of birch or scrub, and areas of acid heath or bog. These proxies also indicate a relatively mild climate, with mean July temperatures of up to 14°C and winters of –8° to –15°C. The most likely age of the deposits is therefore early MIS 3, that is, marked by the Dansgaard-Oeschger (D-O) interstadials 14–17. Both beetle and pollen evidence point to many similarities between the interstadial at Lynford and the Upton Warren site in Worcestershire – placing it in one of the most important interstadials in the last cold stage in Britain.

At the time of deposition the channel is interpreted as having been a meander cut-off, or oxbow, with still or very slow-flowing water. Large objects, such as bones, entered the channel periodically from the adjacent land surface by processes such as bank collapse. None of the bank areas were preserved, so reconstructions of hominin behaviour have to be inferred from a detailed study of the faunal and lithic remains, combined with taphonomic assessments derived from an analysis of the sediments.

Most of the archaeological material was excavated from deposits referred to as Association B and divided into three main components. These represent depositional phases in the history of the cut-off: B-i, the lowermost, contains sands and gravels that were deposited before the channel became a cut-off; B-ii is characterised by organic silts and sands representing an inactive phase in the cut-off's history during which most of the mammoth bones and artefacts were deposited by slumping; B-iii is a final phase composed of fine and coarse sands and gravels that mark a return to conditions of flowing water. The palaeoenvironmental indicators from B-ii also point to bioturbation, possibly by megafauna.

The faunal assemblage from Association B consists of 1,365 identified specimens of which 91 per cent are the remains of woolly mammoths. In addition eight other large mammal species and two rodents are represented. The mammoth bones are highly fragmented, but represent at least 11 individuals. These are mostly large males. Cut marks were not evident, while carnivore gnawing is extremely rare. Bone breakage for the extraction of marrow and the lack of limb bones is interpreted, on balance, as evidence for hominin utilisation of the carcasses. It is suggested that the riverine location provided Neanderthals with an opportunity to exploit such large prey.

The lithic assemblage consists of 2,720 pieces, including 41 complete and 6 broken handaxes; 85 per cent of these are cordiform, ovate and subtriangular in form. Association B-ii also produced 20 flake tools. Microwear studies revealed very little evidence for use, although some refitting was possible. The assemblage is made predominantly on local Norfolk flint and conforms to the pattern known from Britain after 67ka, when lithic assemblages show little evidence of the use of the Levallois technique, but contain many handaxes. The technological skill involved in the manufacture of the artefacts indicates anticipation, but not prediction, on the part of the Neanderthals. In addition, a sandstone block was excavated, which bears use traces made by a softer material, possibly wood. While no original

residues survive on the block it can be considered the earliest candidate-object for the production of fire using a striker.

The evidence from Lynford can be used to investigate the environmental tolerances and habitat preferences of Neanderthals that resulted in the re-occupation of Britain after a long hiatus during MIS 4 – an extremely harsh phase of the last cold stage. Occupation of the locale occurred well before Modern humans (*Homo sapiens*) reached north-western Europe, and patterns of Neanderthal land use and foraging behaviour are examined by studying a hierarchy of catchments based on the palaeoenvironmental evidence. The volume concludes by considering the socioecology of the Lynford Neanderthals and the relationship between their social structure and the distribution of resources in the landscape. Lynford presents an opportunity to consider a major change in hominin/human social organisation that occurred during the last cold stage.

5

The archaeological assemblages of animals and lithics

Besides a rich array of environmental evidence (chapter 3), the Lynford channel contained two large assemblages of stone tools and animal bones. It was this archaeological association, apparent to John Lord when he discovered the site, that marked it out as especially important and worthy of detailed excavation. Furthermore, the preponderance of mammoth bones and the occurrence of distinctive bout coupé *handaxes raised the prospect of investigating whether Neanderthals exploited such large animals, and if so how?*

Chapter 4 examined where the archaeological material originated and how it had slumped into the channel. This chapter gives further information from observations of the preservation of the bones and the degree of abrasion on the artefacts. The question then arises: is Lynford the site, much sought after by Palaeolithic archaeologists, where 'smoking gun' evidence in the form of a stone spear-point embedded in a rib cage demonstrates deliberate hunting of such large animals? Such easy solutions are rarely encountered in Palaeolithic research, and Lynford is no exception. What might at first seem a simple relationship between the faunal assemblages and the Neanderthals who created them turns out to be more complicated, but also more interesting, for our understandings of the capabilities of these hominins. Indeed, the Lynford evidence challenges what we understand by hunting and what we will accept as evidence that it took place.

The Lynford animal bones are dominated by the remains of at least 11 mammoths, mostly large males. Not all the anatomical elements are represented and it is this observation that drives the analysis of how the accumulations of stones and bones built up. There are just under 3000 lithics, including 85 retouched tools. Attention focuses on the patterns of knapping as much as on the varied shapes of the 41 complete handaxes that were excavated. What emerges is a picture of skilled flint-knappers who carefully selected raw material from that available in their local environment, worked to a plan, and frequently recycled the products. Their goal was to make a handaxe with a range of functions that would be adaptable to a variety of circumstances in these open, cold landscapes, which were well stocked with large herbivores. A further glimpse of Neanderthal survival skills is also provided by a small sandstone block that could possibly be one of the earliest examples of a fire-making technology. Such capacity is not unexpected, but until now has proved elusive.

5.1 The vertebrate assemblage from Lynford: taphonomy, biostratigraphy and implications for Middle Palaeolithic subsistence strategies

D C Schreve with contributions by
D R Brothwell and A J Stuart

Materials and methodology

The larger vertebrate material was excavated by hand, with the majority of specimens assigned an individual finds number and context and recorded in three dimensions (see Appendix 4). Seventy-seven specimens were collected from spoil dumps in various parts of the quarry, but could still be related to their original contexts. These are included in the following discussion where stated, but have been excluded from the majority of the analyses described later. Objects smaller than 20mm were allocated a spit number, with the exception of some from contexts that were excavated without using a spit system. Tusks extending into control sections left standing until towards the end of the excavation were excavated in two parts, each of which was given an individual object number. The complete tusk was then assigned a master number in post-excavation; these cases, where more than one individual number was superseded by a master number, are shown in Appendix 4. Specimens were normally bagged in field-damp condition, unless particularly fragile or complex, in which case they were conserved and jacketed in plaster before being lifted (see Appendix 4 for further details). Of the individually numbered finds, 432 were initially sent to the Department of Archaeological Sciences at the University of Bradford for cleaning, exposure of material in plaster jackets where required, and basic conservation work. The remainder were removed directly to the Department of Geography, Royal Holloway, for identification and analysis. A total of 2014 individually numbered finds was excavated, of which 1362 were identified to species, genus or family level. Thirty-seven specimens, mostly cranial, rib and small long bone fragments, were identified as 'large mammal' (size of *Mammuthus* or *Coelodonta*), but lacked sufficient diagnostic characters for further identification. A further 652 specimens (32 per cent of the assemblage) were unidentifiable.

In addition to the recovery of large vertebrate material, bulk sampling for microvertebrate remains was undertaken on site. Thirty-seven bulk samples weighing a combined total of 450.694kg were extracted in five serial column samples from the 1m-wide baulks and other appropriate exposures. The serial samples were taken in spits of approximately 100mm depth, or down to the nearest stratigraphical junction, and were located in such a way as to ensure that both marginal (channel-edge) and deeper water contexts were evaluated and that the columns were directly relatable to both the pollen profile and to column samples taken for other biological data sets. As well as serial bulk samples, a further 38 spot samples were taken from the most calcareous sediments, either from around features such as mammoth tusks, or where patches of small vertebrate material were discovered, as and when they became exposed during the course of the excavations. Specimens considered to be possible coprolites were also bagged on site as spot samples. All of the samples taken are listed in Appendix 3, Table 1. All bagged samples from the site were transported in field-damp condition to the Department of Geography, Royal Holloway (University of London), where they were first weighed and air-dried before being wet-sieved through a 500µm mesh. The sieved residues were then dried, scanned under a low-power binocular microscope and vertebrate remains extracted where present. The material was subdivided into fish, herpetofaunal, birds and mammals and assigned to appropriate specialists where necessary. Additional vertebrate material was obtained from 21 bulk sample residues taken for malacological analysis (Keen, chapter 3).

All sediment from principal deposits was sieved on site through 6mm and 9mm meshes, with one spit unit per 1.0m2 wet-sieved (total 700 spits) and three dry-sieved (2,872 spits), and the residues scanned by eye for microvertebrates and other small bone fragments. Finds recovered from wet- and dry-sieved spits are presented in Appendix 4, Tables A4.2 and A4.3).

Systematic taxonomic determinations of the Lynford mammalian material were established using modern and comparative skeletal material in the Departments of Zoology and Palaeontology at the Natural History Museum and in the Department of Geography at Royal Holloway. Small vertebrate remains were measured using a low-powered stereo zoom microscope with a Pixera Pro 600ES Colour camera. Images were captured and measured using Image Pro-Express with in-built measuring software. Standard measurements on large mammal specimens were made using Vernier callipers (to 0.02mm), according to Von den Driesch (1976).

Secondary data: NISP and MNIs

Numbers of Identified Specimens (NISP) and Minimum Numbers of Individuals (MNIs) are shown in Table 5.1. Calculations of NISP are based on the presence of individual identifiable elements. MNIs have been calculated by dividing the NISP according to the most commonly represented anatomical parts (taking the side into consideration) for each species – that is, calculating the smallest number of individuals required to account for all of the skeletal elements of a particular species at the site. The degree of wear in the dental elements, as well as the overall size of the element, the inferred age of the animal and its sex, where determinable, were also taken into consideration in order to maximise the potential number of individuals recorded. For the purposes of the analysis, each individual

Table 5.1 Minimum numbers of individuals (MNI) per taxon, based on 1401 identified specimens (excluding material from the bulk and sieved spit residues and all undetermined material). The distribution of body part fragments per taxon for all individually numbered finds is shown in bold type and the percentage of each element of the total for that taxon in italics: 'a' denotes an adult animal and 'j' a juvenile. Figures are based on counts of one element per finds number as individual bags may contain tens or hundreds of fragments. Actual numbers of fragments per individual find may therefore be higher (*see* Appendix 4, Table A4.4 for details). Where an individual finds bag contained more than a single body element (eg cranial and rib fragments), a score of 1 has been given to each category.

	B. priscus	*Cervidae*	*R. tarandus*	*C. antiquitatis*	*E. ferus*	*M. primigenius*	*C. crocuta*	*U. arctos*	*V. cf. vulpes*	*C. lupus*
antler		**5** *83.3*	**40** *54.8*							
tusk						**392** *31.4*				
cranial fragments						**352** *28.4*				
jugal						**7** *0.6*				
tusk alveolus						**12** *1*				
tooth			**4** *6.8*	**10** *71.4*	**3** *50*	**30*** *2.4*	**1** *100*	**7** *87.5*	**1** *100*	
Mammuthus *molar fragments*						**92** *7.4*				
mandible		**1** *8.4*	**2** *2.7*			**16** *1.3*		**1** *12.5*		**3** *50*
maxilla and palate						**8** *0.6*				
vertebra			**3** *4.1*			**27** *2.2*				
rib			**1** *1.4*			**130** *10.4*				**1** *17*
sternum						**4** *0.3*				
scapula						**4** *0.3*				
humerus	**3** *74*		**3** *4.1*	**2** *14.4*		**4** *0.3*				
ulna			**1** *1.4*			**2** *0.2*				**2** *33*
radius			**1** *1.4*			**1** *0.1*				
pelvis			**2** *2.7*	**1** *7.1*		**10** *0.8*				
femur		**1** *8.4*	**4** *5.5*		**1** *17*	**7** *0.6*				

continued ▸

Table 5.1 – *continued*

	B. priscus	*Cervidae*	*R. tarandus*	*C. antiquitatis*	*E. ferus*	*M. primigenius*	*C. crocuta*	*U. arctos*	*V. cf. vulpes*	*C. lupus*
tibia			**5** *6.8*	**1** *7.1*		**3** *0.2*				
indet long bones and bone frags			**1** *1.4*			**138** *11.1*				
podials					**2** *33*	**4** *0.3*				
metapodials	**1** *25*		**3** *4.1*							
phalanges			**2** *2.7*			**2** *0.2*				
% of assemblage	**0.3**	**0.4**	**5.4**	**1**	**0.4**	**91.3**	**0.07**	**0.6**	**0.07**	**0.4**
MNI	**2a**	**1a**	**7a** **1j**	**2a** **2j**	**2a**	**10a** **1j**	**1a**	**1a**	**1a**	**1a**

find was treated as a single specimen, although in the case of more fragile elements, such as cranium or mammoth tusk, there might be tens or even hundreds of small fragments in each finds bag.

It was not possible to calculate Minimum Numbers of Elements – the number of complete skeletal elements required to account for all the fragments of that skeletal part for each taxon – because the comminuted nature of the assemblage has resulted in a lack of usable counting portions. In particular, the predominance of multiple small fragments of mammoth tusk, cranium, rib midshaft and shards of long bone diaphyses made it impossible to ascertain how many fragments would make up a single complete element.

It is apparent that taphonomic processes have resulted in very different depositional histories for the vertebrate fossils (*see below*), although the supposed accumulation of the main palaeochannel sediments occurred over only a short space of time, perhaps just tens of years (Keen, Field, chapter 3). The NISP and MNIs are therefore not intended to demonstrate changing relative frequencies over time, but simply to provide a broad indication of the relative abundances of bones of different species in the vicinity at the time of the main channel infilling. The assumptions inherent in using these simple calculations are fully acknowledged (see Ringrose 1993; Lyman 1994b) and the taphonomic biases that potentially influence them are discussed fully in the section on taphonomy.

The stratigraphical distribution of the vertebrate remains

With the exception of three specimens recovered unstratified from the high-energy sands and gravels of Association C, all vertebrate remains were collected from the different units within the underlying palaeochannel deposits that make up Association B (Boismier, Lewis, chapter 2). The distribution of the finds according to context is shown in Table 5.2. Eleven specimens were recovered from deposits attributed to Association B-i:03, comprising a series of coarse flint gravels of fluvial origin below the organic-rich sediments of the palaeochannel, and one from B-i, although no further provenance was recorded. One specimen with a double context number (20003+20384) was found spanning the contact between the sands of B-ii:01 and the organic sediment of B-ii:03. The principal source of the fossils was Association B-ii, which forms the main palaeochannel context (20032). 141 individually-numbered specimens were recorded from unit B-ii:01, which consists of grey-pale-brown sands at the base of B-ii, and

Table 5.2 Abundance and percentage data based on 2091 vertebrate finds with context data, arranged according to context and stating the percentage for each context of the total assemblage

NISP per large mammal taxon

facies association	*context*	*sediment field description*	*C. lupus*	*V. cf. vuples*	*U. arctos*	*C. crocuta*	*M. primigenius*	*E. ferus*	*C. antiquitatis*	*R. tarandus*	*Cervidae*	*B. priscus*	*total no. of individual finds*	*% of individual finds per context*
B-ii:01	20004	basal sands and clay, fill of channel 20032					3			1			7	0.33
	20133	brown sand, fill of channel 20032					1						2	0.10
	20139	brown grey sand, fill of channel 20032					2						3	0.14
	20245	brown sand, fill of channel 20032					5			1			9	0.43
	20254	grey brown sand, fill of channel 20032					21						39	1.87
	20255	brown silty sand, fill of channel 20032					1						1	0.05
	20363	brown gravelly sand, fill of channel 20032											1	0.05
	20364	brown silty sand, fill of channel 20032					9						14	0.67
	20369	yellow brown silty sand, fill of channel 20032					20		1	1			30	1.43
	20375	grey sand, fill of channel 20032					1						1	0.05
	20384	grey brown sand, fill of channel 20032					25			2		1	33	1.58
B-ii:02	20371	green grey clayey silt, fill of channel 20032					2						4	0.19
	20246	organic clayey silt with medium–coarse gravel										1	1	0.05
B-i:03	20051	orange gravel					1			1			2	0.10
	20078	pale brown sandy clay, fill of channel 20032					3						6	0.29
	20129	grey, yellow and orange laminated sand, fill of channel 20027					1						2	0.10
	20130	orange gravel, fill of channel 20024											1	0.05

continued ▸

Table 5.2 – *continued*

			NISP per large mammal taxon											
facies association	*context*	*sediment field description*	*C. lupus*	*V. cf. vuples*	*U. arctos*	*C. crocuta*	*M. primigenius*	*E. ferus*	*C. antiquitatis*	*R. tarandus*	*Cervidae*	*B. priscus*	*total no. of individual finds*	*% of individual finds per context*
B-ii:03	20003	dark brown/black organic sand, fill of channel 20032	6	1	7	1	852	3	11	51	6	2	1422	68.01
	20003 and 20252	dark brown/black organic sands, fill of 20032					1							0.05
	20021	black organic sand (W. end of site), fill of channel 20032					164	3		3	1		267	12.77
	20135	part of organic silty sand											1	0.05
	20248	brown black sandy organic, fill of channel 20032			1		16			2			25	1.20
	20250	brown silty sand, fill of channel 20032					1						1	0.05
	20252	brown black sandy organic, fill of channel 20032				(1)	38			2			59	2.82
	20258	brown organic sand, fill of channel 20032					9			3			16	0.77
B-ii:03 and 01	20003 and 20364	dark brown/black organic sand and brown silty sand, fill of channel 20032											1	0.05
B-ii:03 and 01	20003 and 20369	dark brown/black organic sand and yellow brown silty sand, fill of channel 20032					1						1	0.05
B-ii:03 and 01	20003 and 20371	dark brown/black organic sand and green grey clayey silt, fill of channel 20030											1	0.05
B-ii:03 and 01	20003 and 20384	dark brown/black organic sand and grey brown sand, fill of channel 20032											1	0.05
B-ii:03 and 04	20003 and 20140	dark brown/black organic sand and yellow brown silty sand, fill of channel 20032					6						14	0.67
B-ii:04	20053	medium to coarse sands and gravels											1	0.05
	20131	pale grey sand and gravel, fill of channel 20032					8		1				9	0.43

continued ▸

Table 5.2 – *continued*

			NISP per large mammal taxon											
facies association	*context*	*sediment field description*	*C. lupus*	*V. cf. vuples*	*U. arctos*	*C. crocuta*	*M. primigenius*	*E. ferus*	*C. antiquitatis*	*R. tarandus*	*Cervidae*	*B. priscus*	*total no. of individual finds*	*% of individual finds per context*
	20132	orange gravel, fill of channel 20032					3			1			5	0.24
	20134	orange yellow sand and gravel, fill of cut 20138					1						1	0.05
	20140	yellow brown silty sand, fill of channel 20032											1	0.05
	20247	grey sand, fill of channel 20032					7						12	0.57
	20249	grey gravelly sand, fill of channel 20032					2						2	0.10
	20251	grey and orange sandy gravel, fill of channel 20032					1						2	0.10
	20365	medium–coarse sands, small–medium gravels											1	0.05
	20366	orange yellow sand, fill of channel 20032					3						3	0.14
	20367	yellow white sand, fill of channel 20032					3						4	0.19
	20374	yellow gravel, fill of channel 20.032											1	0.05
	20389	yellow sand and gravel, fill of channel 20032					1						1	0.05
B-ii:04 and 02	20374 and 20371	see above					1						1	0.05
B-ii:05	20002	laminated sands and organic material, fill of 20032											2	0.10
	20005	laminated sand deposit, fill of scour 20006											1	0.05
	20116	brown and orange laminated sand, fill of 20117					1			1			3	0.14
	20119	orange brown silty sand					1						1	0.05
	20136	grey and orange laminated sand											1	0.05

continued ▸

Table 5.2 – *continued*

			NISP per large mammal taxon											
facies association	*context*	*sediment field description*	*C. lupus*	*V. cf. vuples*	*U. arctos*	*C. crocuta*	*M. primigenius*	*E. ferus*	*C. antiquitatis*	*R. tarandus*	*Cervidae*	*B. priscus*	*total no. of individual finds*	*% of individual finds per context*
B-iii	20018	grey sand, fill of channel 20019					1						1	0.05
	20028	orange yellow sand and gravel, fill of channel 20121					5						5	0.24
C	20009	blue-black and orange gravel and sand, fill of scour								1			2	0.10
–	20011	yellow brown sand, fill of channel 20045							1				1	0.05
–	20022	number not used/unstratified											1	0.05
–	20044	no data					5						6	0.29
–	20048	unstratified, from spoil in centre of quarry					27			2			29	1.39
–	20049	unstratified, from spoil in west of quarry								1			1	0.05
–	20050	unstratified					20						20	0.96
–	20052	destroyed/disturbed sediment					4						6	0.29
–	20356	redeposited on W. edge of site during quarrying					1						1	0.05
–	20385	unstratified					1						1	0.05

five from the overlying B-ii:02, a discontinuous dark grey-greenish-brown organic clayey silt. However, by far the richest unit was B-ii:03, with 1804 specimens comprising 90 per cent of the individually numbered mammalian assemblage. Material from this unit comes from seven separate contexts (20003, 20021, 20135, 20248, 20250, 20252 and 20258), all of which have been attributed to Facies B-ii:03, an *in situ* detrital fine-grained, dark-brown organic silty sand found between apparent phases of debris flow and bank collapse. Most significant among these richly fossiliferous contexts were a dark brown-black organic sand (20003) and a black organic sand (20021), which contributed 1422 and 266 specimens respectively (70 per cent and 13 per cent of the assemblage). Fourteen specimens bearing double context numbers (20003+20140) appear to come from the contact between *in situ* organic silty sands and a coarse, orange sand reflecting a subsequent period of debris flow.

The deposits of the main palaeochannel overlap to a certain degree, and the different contexts recorded above might thus form parts of a single laterally variable surface. This is highlighted by the presence of refitting artefacts within the different palaeochannel facies, which indicates that there has been vertical movement (White, this chapter). Nevertheless, the predominance of a single context (20003) as the source of the material further suggests that, as with the archaeological record, the vertebrate assemblage from the main palaeochannel could possibly be considered as a coherent single unit, even though it is clearly time-averaged (see below). In this respect, the observation that 90 per cent of the assemblage is from the dark-brown organic silty sands, and not from other facies within B-ii:03 that have been attributed to debris flows, is also significant. However, unlike the archaeology from the main palaeochannel, the vertebrate remains individually show different degrees of weathering and other evidence of exposure prior to burial. Therefore, although some specimens might be contemporary with the infilling of the main palaeochannel, others have clearly lain on the adjacent land surface for varying numbers of years before being incorporated through over-bank flooding or bank collapse. This presents certain difficulties in analysis, for although apparently entering the palaeochannel more or less synchronously the bones probably accumulated over a somewhat wider time range than the inferred tens of years during which the channel became filled in.

A small number of specimens were recovered from contexts post-dating B-ii:03. Forty-seven specimens were recorded from unit B-ii:04 and six from B-ii:05, a series of mixed deposits of sands and gravels reflecting a period of more energetic fluvial conditions. Nine specimens were recovered from predominantly sandy organic deposits of Association B-iii, which cuts into the deposits of Association B-ii and represents the uppermost infill of the palaeochannel. As reported above, three specimens are known from Association C.

Systematic palaeontology

Twelve mammalian taxa have been identified at Lynford, in addition to four fish taxa and a single avian taxon. The genus *Homo* (presumably *Homo neanderthalensis*) is included on the basis of artefactual material, although no skeletal remains were present. A single herpetofaunal species, the common frog, is also recorded (see Gleed-Owen, this chapter).

Pisces
Esociformes
Esocidae
Esox lucius Linné, 1758, pike

Gasterosteiformes
Gasterosteidae
Gasterosteus aculeatus Linné, 1758,
three-spined stickleback

Cypriniformes
Cyprinidae undet., cyprinid

Perciformes
Percidae
Perca fluviatilis Linné, 1758, perch

Amphibia
Anura
Ranidae
Rana temporaria Linné, 1758, common
or grass frog

Aves
Gruiformes
Rallidae
Porzana sp(p)., crake(s)

Mammalia
Rodentia
Sciuridae
Spermophilus sp., ground squirrel

Cricetidae
Microtus gregalis (Pallas 1779),
narrow-skulled vole

Microtus sp., indeterminate vole

Primates
Homininae
Homo sp. (artefacts and modified bone)

Carnivora
Canidae
Canis lupus Linné, 1758, wolf
Vulpes cf. vulpes Linné,.75 1758, red fox

Ursidae

Ursus arctos Linné, 1758, brown bear

Hyaenidae

Crocuta crocuta Erxleben, 1777, spotted hyaena

Proboscidea
Elephantidae

Mammuthus primigenius (Blumenbach 1803),
woolly mammoth

Perissodactyla
Equidae

Equus ferus Boddaert, 1785, horse

Rhinocerotidae

Coelodonta antiquitatis (Blumenbach 1807), woolly rhinoceros

Artiodactlya
Cervidae

Rangifer tarandus Linné, 1758, reindeer

Bovidae
Bison priscus Bojanus, 1827, bison

The following systematic descriptions relate only to the mammalian material in the assemblage. Full details of the specimens are given in Appendix 4.

Rodentia Bowdich, 1821
Sciuridae Gray, 1821
Spermophilus sp., ground squirrel

The ground squirrel is represented at Lynford by two molars (L m2 and L M1) from the wet-sieved spit residues (61883 and 61610 respectively). Two individuals are indicated, as the specimens present markedly different stages of wear (the L m2 is extremely worn but the L M1 is only in mid-wear). Measurements are given in Table 5.3. The dentition of *Spermophilus* is characterised by a single pair of continuously growing incisor teeth in both the upper and lower jaws. The cheek teeth are rooted and low-crowned with low, rounded cusps on the margins, connected to each other by weak transverse ridges (Matthews 1960). Characters for the identification of *Spermophilus* and its separation from *Sciurus* are given by Chaline (1966). Of note are the relatively larger size of the upper anterior premolars and the greater height of the tubercles and principal ridges in the cheek teeth in *Spermophilus*. The crowns of the upper molars are a conspicuous 'U' shape in occlusal view when moderately worn. The lower molariform teeth are similar to Sciurus, although the crowns are higher and more compressed, the cusps much more prominent and the central depression deeper and narrower. The skull is considered to be more massive than in the arboreal squirrels, and the postcranial skeleton is modified to cope with a strictly terrestrial existence in the form of less elongated feet and short, flattened dorsal vertebrae (Miller 1912). The taxonomic classification of modern Palaearctic species of *Spermophilus* is extremely unstable, although nine species are currently recognised (Corbet 1978). On the basis of the limited material from Lynford, including an extremely worn specimen, specific determination has not been attempted. The earliest records of ground squirrel are from the Arctic Freshwater Beds, deposits that pre-date Anglian till at Mundesley, Norfolk (Newton 1882), but the greatest abundance occurs in the deposits of the lower Middle Terrace of the Thames, at sites such as Crayford, Kent (Kennard 1944).

Table 5.3 Measurements of *Spermophilus* sp.: all measurements in mm (L = maximum length; B = maximum breadth)

Spermophilus sp.	L	B
61883 L m2	3.16	2.18
61610L M1	2.67	2.25

Cricetidae Rochebrune 1883
Microtus gregalis (Pallas 1779), tundra or narrow-skulled vole

The tundra vole is represented by five specimens, indicating five individuals, all from wet-sieved spit residues (60152 L dentary with broken m1; 61096 anterior L m1; 61497 L dentary with m1; 63646 L m1 and 608?? [sample number partially erased] L m1). Measurements are given in Table 5.4. The first lower molar in *M. gregalis* is readily identifiable, possessing three inner and two outer closed triangles with a distinctive 'mitten-shaped' anterior loop. An ancestral morphotype of this species, *Microtus gregaloides* (Hinton 1923), is known from early Middle Pleistocene temperate episodes at West Runton (Stuart 1996) and Westbury-sub-Mendip (Currant 1999). A single occurrence in the late Middle Pleistocene is recorded at Pontnewydd Cave (Schreve 1997), but the majority of finds are known from the Devensian (Sutcliffe and Kowalski 1976), where populations display a high degree of intra-specific morphological variation. The specimen from spit sample 61497 at Lynford reflects this variability since it does not present the classic anterior loop, but does have the strong enamel differentiation that is also characteristic of this species.

A further 30 remains extracted from the bulk samples and wet-sieved spit residues, comprising incisor fragments, molars other than m1 and molar fragments, could be attributed to Microtus sp. or Microtinae but lacked sufficient diagnostic characters for further determination (30.200 600–700mm molar fragment; 30.226 190–290mm R M1 and

Table 5.4 Measurements of *Microtus gregalis*: all measurements in mm (L = maximum length)

Microtus gregalis	L
607?? L m1	2.61
61497 L m1	2.83
63646 L m1	2.66

I fragment; 30.228 01 juvenile molar fragment; 30.234 02 R I, 30.235 0–100mm L m2; 30.235 100–200mm I fragment; 60297 L I; 60379 i fragment; 60523 i fragment; 60992 R I; 60996 R m1 fragment; 61280 I fragment; 61482 I fragment; 61540 R M3; 61606 anterior L m2 fragment; 61640b L I; 61642 R I; 61723 R m1 fragment; 61906 i fragment; 62218 R M3; 62422 I fragment; 62429 R I; 62504 L i and i fragment; 62976 i fragment; 63125 L I; 63214 L I; 63808 R m2 and 64764 i fragments).

Carnivora Bowdich, 1821
Canidae Gray, 1821
Canis lupus Linné, 1758, wolf

Wolf is represented by the articular condyle of a left dentary, two conjoining right mandible fragments (one with a fragment of second lower molar *in situ*), a proximal rib fragment and two conjoining fragments of a right ulna (Fig 5.1). A solitary R p2 was also recovered from the wet-sieved residue of spit 61235. Measurements are given in Table 5.5. Kurtén and Poulianos (1977) have suggested that *C. lupus* originated from one of the small Villafranchian canids, either C. etruscus Major or *C. arnensis* Del Campana. Wolves of the early Middle Pleistocene have been attributed to a small-bodied species or subspecies, *Canis mosbachensis* or *Canis lupus mosbachensis*. According to Bonifay (1971), the first known occurrence of the true wolf is in the Holsteinian, and the species increases progressively in size throughout the Middle and Late Pleistocene until it reaches a maximum in the Devensian (Schreve 1997). These results are paralleled by findings on the continent by Bonifay (1966, 1971).

Vulpes cf. *vulpes* L., 1758, red fox

A small canid, attributed to *V*. cf. *vulpes*, is represented by a single find of a right upper canine. The specimen is of smaller size and more slender form that the equivalent tooth in *C. lupus*, and compares most closely with modern red fox from Britain. The red fox can be differentiated from the Arctic fox, (*Alopex lagopus* L. 1758), on the basis of its larger size, greater robustness, more elongated dentary and more widely-spaced premolars, but on the basis of only a single canine from Lynford the specific attribution can remain only tentative at present. *V. vulpes* probably evolved from the ancestral *V. alopecoides* during the Middle Villafranchian (Kurtén 1968). The earliest record to date of *V. vulpes* in Britain is from the early Middle Pleistocene site of Westbury-sub-Mendip (Bishop 1982).

Fig 5.1
Partial right ulna of Canis lupus *(51860), anterior view (scale in mm).*

Table 5.5 Measurements of *Canis lupus*: all measurements in mm (L = maximum length; B = maximum breadth; BPC = greatest breadth across coronoid process)

Canis lupus	L	B	BPC
61235 R p2	14.86	8.04	
51860 R ulna			16.42

Fig 5.2 (top right) Associated L m1 (51212) and R m1 (51726) of Ursus arctos*, lingual view (scale in mm).*

Ursidae Gray, 1825

Ursus arctos L., brown bear

Remains of brown bear from Lynford comprise a fragment of right dentary with p1 alveolus, found in association with a R c, a basal canine fragment including the root, an associated L and R m1 (Fig 5.2), a L m2 (Fig 5.3), a R m3, a broken C tip and a partial root and enamel fragment of a R C. Measurements are given in Table 5.6. The canines of brown bear are long and robust and lack the pronounced median ridge on the lingual side that is seen in large felids. The cheek teeth are bunodont with large occlusal expansions adapted for crushing. In contrast to the cave bear, *Ursus spelaeus* (Rosenmüller and Heinroth 1794), *U. arctos* nearly always retains two small anterior premolars in the upper jaw and at least one in the lower jaw (Reynolds 1906) and has generally higher-crowned teeth than those of the cave bear. The postcranial remains are normally more robust than in large felids of equivalent size but are smaller than those of the cave bear. The brown bears have their origins in China, where they have a continuous record from the early Middle Pleistocene to the present day (Kurtén 1968). According to Kurtén (1959), they share a common ancestor with U. spelaeus in the small Early Pleistocene bear, U. etruscus Cuvier. The brown bear appears in Europe for the first time during the Holsteinian interglacial at sites such as Lunel-Viel, France, where it

Table 5.6 Measurements of *Ursus arctos*: all measurements in mm (L = maximum length; B = maximum breadth)

Ursus arctos	L	B	max height (from crown to root tip)
51212 L m1	26.30	13.74	31.00
51726 E m1	25.92	13.38	31.10
50558 L m2	27.46	17.92	32.06

Fig 5.3 L m2 (50558) of Ursus arctos*, lingual view (scale in mm).*

co-existed with the cave bear (Kurtén 1968) but did not enter Britain until MIS 9, when it completely supplanted U. spelaeus (Schreve 2001a; Schreve and Currant 2003).

Hyaenidae Gray, 1869

Crocuta crocuta Erxleben, 1777, spotted hyaena

Although amply represented at Lynford by characteristic gnawed bones, the digested teeth of prey species and occasional coprolites, actual fossil remains of the spotted hyaena at the site consist only of a single posterior fragment of a well-worn L p4 and a second phalanx from dry-sieved spit 60726, the latter showing clear signs of digestion (Fig 5.4). The dentition of *C. crocuta* is highly specialised. The post-carnassial molars are either vestigial or have been lost completely, and the m1 is bicuspid, as in felids. The canines are rather small, whereas the premolars have been modified into massive conical structures, adapted for crushing bones (Stuart 1982). Turner (1981) has demonstrated that from the Ipswichian to the Devensian, there was a decrease in the tooth size of p1–3 and an increase in the size of p4-m1 in *C. crocuta*. This indicates an overall shift in power and chewing efficiency towards the more posterior cheek teeth during the Devensian. The ancestor of *C. crocuta* is thought to be the Villafranchian *C. sivalensis* (Falconer and Cautley), which spread out from its origins in India in the early Middle Pleistocene (Kurtén 1968). *C. crocuta* first appeared in Britain in the early Cromerian Complex at West Runton, Norfolk (Stuart 1996) and went on to be the only species of hyaena present in Britain during the later Middle Pleistocene. Later Cromerian Complex finds of *C. crocuta* include remains from Westbury-sub-Mendip (Bishop 1982). The species is apparently absent from the Hoxnian in Britain (Schreve 2001a) and indeed from contemporary deposits across NW Europe (Schreve and Bridgland 2002), although it reappears during the subsequent MIS 9 interglacial at sites such as Purfleet and Grays in Essex (Schreve 2001a) and is a regular component of all later interglacials. It is absent from Britain during the Early Devensian, but reappears during the middle part of the last cold stage (Currant and Jacobi 2001), where it is present as a particularly robust morphotype (Kurtén 1968). A coprolite (30,161) from Lynford was sampled for ancient DNA.

Fig 5.4
Second phalanx of Crocuta crocuta *(anterior view).*

Proboscidea Illiger, 1811

Elephantidae Gray, 1821

Mammuthus primigenius (Blumenbach, 1803), woolly mammoth

The mammoth assemblage from Lynford includes many thousands of tusk fragments (391 finds), cranial fragments (353 finds) and ribs and rib fragments (130 finds). In addition to a mandible with L and R m3 *in situ* (51046 and 51047), and a crushed maxilla with R M2 *in situ* (Fig 5.5) (51619 + 51038), twenty-seven isolated molars or partial fragments were noted. These comprise a R dp4 or m1 (50137), L m2 (51730), L m2 or m3 (51252), 2 R m2s (51710, 50358), partial R ?m2 (52038), 3 L m3s (Fig 5.6), 50656, 50000, 51997), R m3 (51953 + 51648 + 51154), fragmentary R m3 (51820), 2 L M1s (51171, 51234), 3 R M1s (51201, 51440, 51240), 2 L M2s (51966, 50002), R M2 (50003), 2 L M3s (Fig 5.7), 50273, 50001), partial L M3 (51965), R M3 (50069, 52063) and a fragmentary R M3 (51887). Many hundreds of individual molar plate and root fragments were also recovered. Postcranial material is poorly represented (see later). Measurements are given in Lister (this chapter).

The tusks of *M. primigenius* possess a distinctive spiral twist. The molars are also very diagnostic, with broad crowns and narrow, closely spaced plates with very thin, finely wrinkled enamel. A thick layer of cement is often present, particularly around the edges

Fig 5.5 (top left) Crushed maxilla with R M2 in situ *(51619) of* Mammuthus primigenius*, lingual view (scale in cm).*

Fig 5.6 (top right) L M3 (50000) of Mammuthus primigenius*, lingual view (scale in cm).*

of the occlusal surface. The plates wear to narrow ribbons with no median expansion, forming thin bands on the occlusal surface (Fig 5.8). Criteria for the identification of the postcranial skeleton are given by Adams (1877–1881), Osborn (1942), Garrutt (1964) and Olsen (1972).

The mammoth lineage shows significant morphological change from the Late Pliocene through to the Late Pleistocene. Although important changes in the cranium and postcranial skeleton occur during this period, the most commonly available and diagnostic elements are the molar teeth. Three main trends are discernible in the molars over time, which are particularly well expressed in the M3. The crowns double in height, the number of enamel plates (lamellae) in the teeth more than doubles and the thickness of the enamel becomes reduced by around two-thirds (Lister 1993). The increased 'tooth-life' resulting from these changes is thought to reflect an adaptation to the coarse vegetation of the 'steppe-tundra' biome, corresponding to a shift in the distribution of the genus from warmer, forested habitats to cold, open regions during the Pleistocene (Lister 1993). On the basis of these trends, four chronospecies have been defined,

Fig 5.7 (bottom left) L m3 (50001) of Mammuthus primigenius*, lingual view (scale in mm).*

Fig 5.8 (bottom right) R M1 (51440) of Mammuthus primigenius*, occlusal view (scale in cm).*

with the following known time ranges in Europe: *Mammuthus rumanus* (Stefanescu), from 3.5Ma to 2.6Ma, *Mammuthus meridionalis* (Nesti) from 2.6Ma to 0.8Ma, *Mammuthus trogontherii* (Pohlig) from 1.0Ma to 0.2Ma and *M. primigenius* from 0.2Ma to 0.01Ma. Their chronological replacement and the lack of alternative ancestors imply that they represent an approximate evolutionary line of descent, although some of the transitions occurred earlier in Asia (Lister *et al* 2005), and overlap between the morphological ranges can be seen at successive stages in the sequence.

The steppe mammoth, *M. trogontherii*, of the type Cromerian interglacial deposits at West Runton (Norfolk) is typically of very large size, with high crowned molars and a relatively low plate count of 19 to 22 plates in the M3 compared to the standard Devensian *M. primigenius*, which has between 20 and 28 plates in the M3. During successively later Middle Pleistocene interglacials, while plate number and hypsodonty index in the molars remain similar to *M. trogontherii*, there is a broad trend towards reduced size. In the late Middle Pleistocene, at sites such as Ilford (Essex), attributed to MIS 7 (Sutcliffe 1995; Schreve 2001a), the same plate count is retained, although size reduction in the tooth continues still further (Lister and Joysey 1992; Lister *et al* 2005). Traditionally, it was thought that intermediate forms between M. trogontherii and M. primigenius began to occur as early as the Elsterian, that forms closer to *M. primigenius* than to *M. trogontherii* appeared during the Saalian and that the fully-evolved *M. primigenius* was restricted to the Late Pleistocene, particularly in Devensian/Weichselian assemblages (Adam 1961; Kurtén 1968). However, it is now apparent that during the Late Middle Pleistocene (c 400–200ka BP), mammoths essentially similar to *M. trogontherii* but of reduced body size persisted in Europe, to be replaced by *M. primigenius* only in MIS 6 (Lister and Sher 2001; Lister *et al* 2005). The Lynford mammoths have a relatively low plate count of 20–22 in the M3, overlapping both *M. primigenius* populations from the last cold stage and *M.* cf. *trogontherii* of the late Middle Pleistocene (*see* Fig 5.47, Lister, this chapter) although this is a known feature among European samples (Lister and Sher 2001; Lister *et al* 2005) and is entirely consistent with the Devensian age inferred from other lines of evidence at the site.

Perissodactyla Owen, 1848

Equidae Gray, 1821

Equus ferus Boddaert, 1785, horse

The horse is represented at Lynford by three teeth (L I1, a R lower cheek tooth (p3-m2) and a R m3) and three postcranial elements, a complete R astragalus, articulating with a complete R calcaneum (Fig 5.9), and a distal right femur (Fig 5.10), possibly from the same individual. The dry-sieved spit residues yielded one additional specimen (64246 L i3) and the wet-sieved spit residues another 3 (64202 R dp germ, 1.2 M fragment and 64001 M fragment). Measurements are given in Table 5.7.

The taxonomy of the Pleistocene equids is extremely complicated, with a plethora of different subspecific names assigned to the various forms. '*Equus caballus*' has been used by certain authors to describe Pleistocene caballine horses (Prat 1966), although this term is only really appropriate for domesticated animals (Gentry *et al* 1996). Consequently, the name *Equus ferus* has been applied here, as to all British later Middle Pleistocene and Late Pleistocene caballine equids. The first caballine horses appeared during the early Middle Pleistocene and have most frequently been assigned to *E. mosbachensis* Reichenau (Prat 1966). The early caballines were of large size and possessed relatively derived dentitions compared to stenonid forms. The cheek teeth of the Equidae are hypsodont with a complex pattern of enamel folds. The upper cheek teeth are characterised by elongated 'caballine' protocones and the inner valley

Table 5.7 Measurements of *Equus ferus*: all measurements in mm, figures in brackets are minimum measurements because of breakage

Equus ferus	L	B	L double knot	max height of tooth	Bd
51612 R lower cheek tooth	31.08	15.80	15.66	(76)	
51631 R m3	32.08	12.16	14.02	(66.88)	
51360 distal R femur					92.92

L = maximum length; B = maximum breadth; Bd = greatest breadth of distal end

Fig 5.9
R calcaneum (51869) of Equus ferus*, proximal view (scale in cm).*

Fig 5.10
Distal R femur (51360) of Equus ferus*, posterior view (scale in cm).*

usually terminates in a simple caballine fold. The buccal infoldings are concave, and both the parastyle and mesostyle have outer vertical grooves, although these might not be present in the upper dentition. The lower cheek teeth have a 'U'-shaped lingual fold and the buccal fold does not extend beyond the isthmus (Turner 1990).

The postcranial bones of the horse are relatively slender for a large animal, and the third metapodials, with their single distal articulation, are particularly diagnostic (Schmid 1972). The calcaneum (*see* Fig 5.9) and astragalus are of typical perissodactyl form, the latter possessing two characteristic diagonally oriented articular facets. In the femur, the *fossa plantaris* is particularly deep (*see* Fig 5.10) and a third trochanter is present. From the later Middle Pleistocene onwards, a general reduction in size can be seen in both the dentition and the overall body size of the caballine horses, although the variation is unfortunately not so great that specimens can always be referred with any certainty to one of the many named species. Furthermore, the age resolution of many older sites is too poor to establish any meaningful succession (Forstén 1991).

Rhinocerotidae Owen 1845
Coelodonta antiquitatis (Blumenbach, 1807), woolly rhinoceros

The woolly rhinoceros is represented by an unworn R DP3, a R DP4 (Fig 5.11), two L P3s (Fig 5.12), three conjoining fragments of a LM, a fragmentary R dp2, L p3, L m1, incomplete R m2, an extremely comminuted lower molar, two medial distal articular fragments of a left and right humerus respectively, a R acetabulum and a juvenile tibia diaphysis. Measurements are given in Table 5.8.

Basic characters for the identification of this species are given by Bouchud (1966a) and Guérin (1980). The massive, low-slung skull is very diagnostic, since the nasal septum is usually completely ossified, and the occiput is large and squarish, with a heavy occipital crest. The teeth, which are the best-represented elements at Lynford, are large in size, plagiolophodont and hypsodont, with extremely rugose enamel and layers of cement layers between the enamel folds on the occlusal surface and on the external walls. The upper dentition is highly distinctive since the crista and crochet fuse to form an isolated enamel islet (medifossette) on the occlusal surface of the upper teeth in both the deciduous and permanent sets (*see* Figs 5.11 and 5.12). The permanent lower cheek teeth are formed of two lobes, which, when viewed from the lingual side, have 'V'-shaped anterior valleys and 'U'-shaped posterior valleys, and pronounced external synclines (Turner 1990). With wear, the anterior lobe of the lower teeth assumes an angular form and the posterior lobe a crescent form on the occlusal surface. The postcranial skeleton, particularly the extremities of the bones, is relatively large and robust.

The earliest appearance of *Coelodonta* in Europe is a matter of contention, with both Anglian and Saalian occurrences cited. *C. antiquitatis* has been identified in Britain from three sites of reportedly Anglian age (Homersfield [Stuart 1982; Lister 1989], King's Newnham/Lawford Pit, Warwickshire and Lillington, Warwickshire [Shotton 1953; Lister 1989]), from four sites in Romania of approximate Elsterian age (Araci-Carieră, Araci-Fintina Fagului, Ghidfalău-1 and Sfintu Gheorghe/Cariere Sud [Rădulescu and Samson 1985]), and from three sites in Germany of Elsterian age (Bad Frankhausen, Bornhausen and Neuekrug [Bouchud 1966a]). Support for an Elsterian (MIS 12) entrance into Europe has recently come from a reappraisal of the Bad Frankenhausen material by Kahlke and Lacombat (2008), although these authors reassign the specimens to *Coelodonta tologoijensis* Belyaeva, an archaic continental Asian woolly rhinoceros first noted from the early Middle Pleistocene onwards. Guérin (1980), on the other hand, limits the first occurrence of the species to the Saalian, regarding the Saalian woolly rhinoceroses as a more primitive subspecies, *C. antiquitatis praecursor*, and recognising a second subspecies, the more evolved and robustly built *C. antiquitatis antiquitatis*, as the Weichselian representative. According to Guérin, the M3s of the Saalian subspecies display a rectangular form, while those of the Weichselian animals possess a triangular form, although this biostratigraphical character has since been dismissed by van Kolfschoten (in van Kolfschoten and Roebroeks 1985). Guérin (1980) also considers the third metatarsal of *C. antiquitatis* to be shorter and stockier in the Weichselian than in the Saalian, and the radius to be longer and stouter but again, little supporting evidence

Fig 5.11
Occlusal view of R DP4 (51401) of Coelodonta antiquitatis *(scale in mm).*

Table 5.8 Measurements of *Coelodonta antiquitatis*: all measurements in mm

Coelodonta antiquitatis	L	B
51324 R DP3	34.60	40.62
51401 R DP4	46.26	42.10
50491 L P3	36.02	39.00

L = maximum length; B = maximum breadth

Fig 5.12
Occlusal view of L P3 (50491) of Coelodonta antiquitatis *(scale in mm).*

was found for this by Turner (1990), since fossils of *C. antiquitatis* tend to be extremely robust whatever the age of their deposit.

However, although there appears to be little basis for Guérin's proposed subspecific division of *C. antiquitatis*, recent investigation by van Kolfschoten (1990) and Turner (1990) into the later Middle Pleistocene mammalian biostratigraphy of the Netherlands and Germany respectively also places the first appearance of the species within the Saalian. Re-examination of the British evidence has drawn similar conclusions (Schreve 1997), since the provenance of the *C. antiquitatis* material at Lillington and the attribution of the remaining aforementioned British localities to the Anglian glaciation are questionable. The first verifiable appearance of *Coelodonta* in Britain is therefore considered to occur within the Saalian *sensu lato*, more precisely in cold-climate sediments attributed to MIS 8 such as Northfleet in Kent and Stoke Newington in London (Schreve 1997). Although *C. antiquitatis* is usually associated with cold-stage faunas and is a typical element of the open steppe (*see* Stuart, this chapter), it is nevertheless recorded from interglacial deposits attributed to the later part of MIS 7, where its presence more probably confirms the opening-up of the environment and the development of steppic grassland, as opposed to a cold climate (Schreve 2001b). The species is a common component of Middle Devensian assemblages but was apparently absent from the early Devensian in Britain (Currant and Jacobi 2001).

Fig 5.13
Antler beam with two tines (50096) of Rangifer tarandus, *lateral view (scale in cm).*

Artiodactyla Owen, 1848
Cervidae Gray, 1821
Rangifer tarandus, L., 1758, reindeer

Remains of *R. tarandus* from Lynford include 40 antlers or antler fragments. Reindeer antlers are especially diagnostic and are carried by both sexes. The beam is long, slender and medio-laterally flattened, either sharply angled halfway along or sweeping upwards in a pronounced forward-directed curve (Fig 5.13). Two basal tines are present, placed low down near the brow and usually with palmated ends. The beam and tines are relatively thick-walled and have a smooth outer surface with broad, shallow gutters. Five isolated teeth were also identified among the excavated finds (R dp2, R p3, L p4 and L m3), one tooth was recovered from the dry-sieved spit residues (61354 L M2) and a further four, from the wet-sieved spit residues (61093 R p4, 62106 lingual fragment of ?R p4, 61648 L m1 and 64764 very worn m1 or m2 fragment). The teeth are smaller than in red deer, being both relatively rounded and very low-crowned with smooth enamel and more pronounced folding of the enamel on the buccal and lingual faces (Turner 1990). Molarisation of the p3 and p4 (Figs 5.14 and 5.15) is typical for this species. Criteria for the identification of the postcranial elements are given in Bouchud (1966b) and Lister (1981). The metapodials of *R. tarandus* differ from those of other cervids in possessing an extremely pronounced posterior groove with splayed distal epiphyses (Fig 5.16). Following an early appearance in probable Anglian levels at Westbury-sub-Mendip (Stringer *et al* 1996), no further unequivocal records of *R. tarandus* are known from Britain until the Devensian, with the sole exception of Balderton, Lincolnshire, attributed to MIS 6 by Lister and Brandon (1991). Measurements are given in Table 5.9.

Bovidae Gray, 1821
cf *Bison priscus* Bojanus, 1827, bison

Only four postcranial fragments of a large bovid have been recovered from Lynford. These are a fragment of proximal end and medial diaphysis of a left radius, two fragmentary

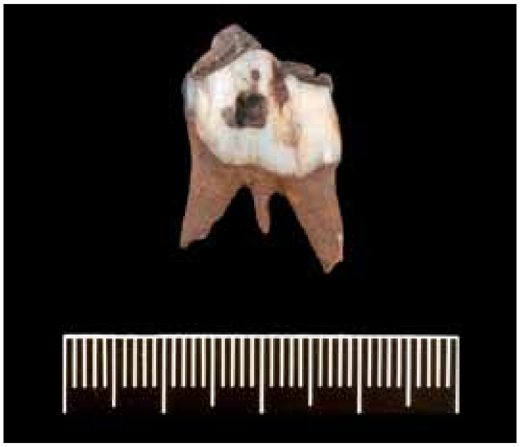


Fig 5.14 (top left)
L p4 (51322) of Rangifer tarandus*, buccal view (scale in mm).*

Fig 5.15 (top right)
L p4 (51322) of Rangifer tarandus*, occlusal view (scale in mm).*

Table 5.9 Measurements of *Rangifer tarandus.*: all measurements in mm

Rangifer tarandus	L	B	LAR	Bp	Dp	SD	Bd	B distal condyle
61354 L M2	17.90	12.00						
51322 L p4	15.70	10.78						
61093 R p4	14.20	10.30						
61648 L m1	15.62	9.44						
50906 L m3	21.30	8.50						
50823 R femoral head		25.30						
51023 L acetabulum			38.86					
50869 L metacarpal	169			33.64	23.70	23.72	41.68	19.82

L = maximum length; B = maximum breadth; Bp = greatest breadth of proximal end; Dp = greatest depth of proximal end; SD = smallest breadth of diaphysis; Bd = greatest breadth of distal end; LAR = length of the acetabulum on the rim

distal left humeri and a proximal posterior fragment of a left metatarsal midshaft (Fig 5.17). Measurements are given in Table 5.10. The remains are in poor condition, showing clear evidence of rolling and breakage, and have been tentatively attributed to Bison (*Bos primigenius* not being recorded from any part of the Devensian except the Late Glacial Interstadial; see Currant and Jacobi 2001). Remains of large bovids are notoriously difficult to identify to species level, and various attempts to define diagnostic characters based on postcranial bones or teeth have been made by a number of authors, for example Schertz (1936), Reynolds (1939), Olsen (1960), Browne (1983) and Gee (1993). Further difficulties are presented by pronounced sexual dimorphism and by wide morphological

Table 5.10 Measurements of *Bison priscus*: all measurements in mm

Bison priscus	BT
51889 distal L humerus	108.64

BT = greatest breadth of trochlea

Fig 5.16
Left metacarpal (50869) of Rangifer tarandus*, anterior view (scale in mm).*

Fig 5.17
Proximal midshaft fragment of left metatarsal (50929) of Bison priscus*, posterior view (scale in mm).*

variability within this group. The skull and horn cores of bison are, however, easily distinguishable, since the horns are angled upwards only, whereas in *Bos primigenius* Bojanus 1827 (aurochs), the horns are twisted in two planes, both forwards and upwards.

The metapodials (particularly the metacarpals) are also widely cited as displaying useful diagnostic features (Schertz 1936; Olsen 1960; Browne 1983; Gee 1993). Those of *B. primigenius* taper gently outwards from diaphysis to distal epiphysis, while those of *B. priscus* diverge outwards above the distal epiphysis, resulting in a 'shouldered' appearance. The applicability of other discriminant characters in the postcranial elements is discussed by Gee (1993). Attempts have also been made to identify *Bos* or *Bison* on the morphology of the upper and lower cheek teeth (Delpech 1983), but the problem of separating the fossil remains of *Bos* and *Bison* has been compounded by questions as to the taxonomic validity of the two genera, since captive populations have been shown to be capable of interbreeding (Krasinska 1971). The two living species, the Eurasian wisent, *Bison bonasus* L., and the North American *Bison bison* L., differ from each other in general body form and colour, but the Pleistocene steppe bison, as portrayed in Upper Palaeolithic cave paintings, was apparently unlike either extant species. Reconstruction of a mummified *B. priscus* carcass from Alaska has revealed that in addition to differences in pelage colour and length, the dorsal hump in the Pleistocene bison was higher, more convex and placed in a more posterior position along the spine than in any living bison (Guthrie 1990).

Although *B. priscus* is known from early Middle Pleistocene sites in Germany, such as Mauer and Mosbach (Turner 1990), the steppe bison does not seem to have entered Britain until after the Anglian, apparently replacing the small, gracile *Bison schoetensacki* Freudenberg, which was present in Europe during the Cromerian and has been tentatively identified at Waverley Wood (Shotton *et al* 1993), and at Westbury-sub-Mendip (Gentry 1999). *B. priscus* is a common element of the early part of the Devensian (MIS 5a; Currant and Jacobi 2001; Gilmour *et al* 2007).

Composition of the large vertebrate assemblage

The presence of differentially weathered bones within the main channel assemblage precludes the possibility of attributing significance to any apparent mammalian faunal change upward through the sequence. All species recorded at the site are present within the dark brown-black organic sands of the main palaeochannel contexts, 20003 and 20021 (*see* Table 5.2), and all carnivore taxa and *E. ferus* are restricted to these two contexts alone. By contrast, *M. primigenius* is more evenly distributed, occurring above, below and within the organic deposits of the main palaeochannel, in all but 15 of the fossiliferous contexts. As with the other species, the greatest concentrations of mammoths are in the organic sands of the main palaeochannel (Association B-ii), but five finds have come from the gravels and sands below the organic sands (B-i:03) and six from the sands and gravels above (B-iii) (*see* Table 5.2). A single specimen of *R tarandus* is also found in each of the coarser sands and gravels above (Association C) and below the main organic sandy silts (Bi:03), and a single find of *C. antiquitatis* was also recovered from Association C. Thus, only mammoths and reindeer occur in sediments pre-dating the deposition of the main organic channel deposits and only these two species, with the addition of woolly rhinoceros, post-date the main channel infilling.

M. primigenius is by far the most abundant species, comprising over 90 per cent of the assemblage of 1401 identified individually-numbered and unstratified finds. At least 11 individuals are represented, including one juvenile. The mammoth remains are dominated by tusk fragments at 31.4 per cent of the mammoth assemblage, cranial fragments (28.4 per cent of the assemblage) and rib fragments (10.4 per cent of the assemblage). The high frequency of these friable elements is considered to be a direct reflection of the taphonomic processes that have affected the assemblage, most noticeably trampling by large mammals (see later). Eight pairs of molars have been found within the assemblage (see Lister, Tables 5.47–5.49, this chapter): 50002 and 50003; 50069 and 50273 (Fig 5.18); 50358 and 51730; 50656a and 51953/51648/51154 (Fig 5.19); 51171 and 51201 (Fig 5.20); 51234 and 51140; 51820 and 51997; and 51965 and 52063), and a possible further association has been noted between an upper and lower pair of second molars (50002–50003 and 50358–51730 respectively, Fig 5.21). The presence of these paired teeth, in addition to the occurrence of fragments of mandibular or maxillary bone between the roots of the molars, indicates that whole jaws and/or crania were initially present on site but have since been destroyed. Only three molars were found to be still *in situ* within jaws: a pair of lower third molars (51046 and 51047) in a mandible, and a right upper second molar in a maxilla (51619). Fifteen complete or partially complete tusks were also excavated and photographed *in situ* within the main palaeochannel deposits (Fig 5.22). Four of these were considered to be sufficiently robust to warrant jacketing in plaster for further conservation, but the remainder proved too fragile to recover.

In sharp contrast, mammoth postcranial elements other than ribs are very poorly represented in the assemblage and are highly variable in terms of their preservation when encountered. In total, 206 individually numbered finds could be attributed to non-rib postcranial elements, comprising only 16 per cent of the total number of mammoth remains (*see* Table 5.1). Of these, more than

Fig 5.18
R and L M3 of Mammuthus primigenius *(50069 and 50273), buccal view (scale in mm).*

Fig 5.19
R and L m3 of Mammuthus primigenius *(51953–51648–51154 and 50656a), lingual view (scale in mm).*

Fig 5.20
R and L M1 of Mammuthus primigenius *(51171 and 51201), buccal view (scale in mm).*

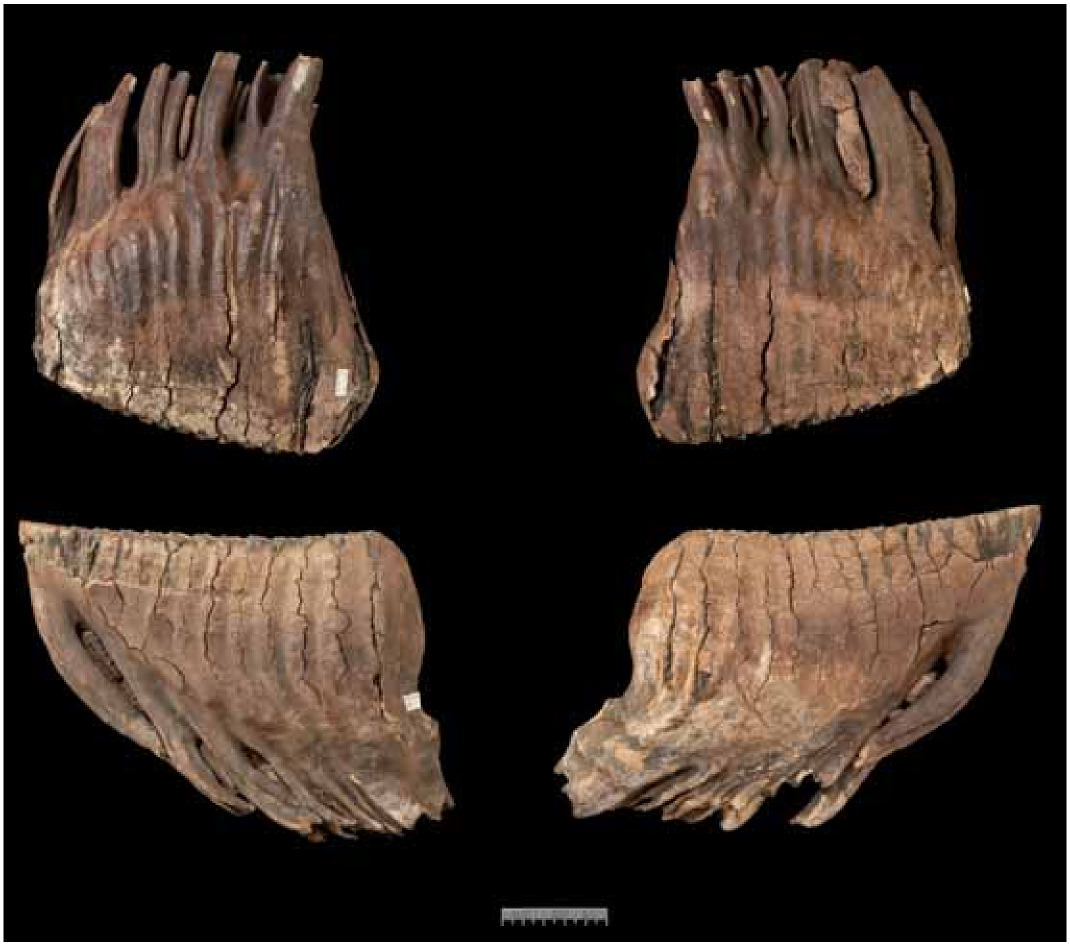


Fig 5.21
Associated R and L second molars of Mammuthus primigenius *(50002–50003 and 50358–51730), buccal view (scale in mm).*

half are fragments of long-bone and other indeterminate postcranial fragments. These rarely exceed 150mm in length and have been reduced in the majority of cases to bone 'shards', which are roughly twice as long as they are wide. Of the remaining non-rib specimens, the most abundant are vertebrae (27 specimens), with smaller numbers of specimens distributed fairly evenly among the major limb elements – never comprising more than 10 finds of each. Four podials were recovered, but no metapodials are present and only two phalanges. This is surprising given the relative robustness of these small, compact elements, although feet are often one of the areas preferentially targeted by carnivores. Only 11 of the vertebrae and 12 ribs approach any degree of completeness and no complete mammoth limb bones are present in the assemblage; the two best-preserved major elements are a proximal left radius (51903) (Fig 5.23) and a proximal right ulna (51976) (Fig 5.24). Where present, limb bones are generally reduced to diaphyseal fragments and, more rarely, epiphyseal elements. Even allowing for the high degree of breakage in the bones, it is clear that long-bones and long-bone fragments are very under-represented within the assemblage. With a minimum number of 11 individuals in an unmodified assemblage, one would expect to encounter 165 major limb bone elements (scapulae, humeri, radii, ulnae, pelvises, femora, tibiae and fibulae) as well as at least 275 vertebrae (not including sacral or caudal vertebrae) and 220 ribs. The paucity of postcranial elements other than ribs and vertebrae must therefore be attributable to *post mortem* differential destruction and removal.

Remains of *R. tarandus* are the next most abundant in the assemblage with 73 specimens, 40 of which (approximately 55 per cent) consist of antlers or antler fragments. At least seven adult animals are present and two juveniles (*see* Table 5.2). Preservation is similarly variable, ranging from large and fairly complete (although often crushed) sections of antler beam to detached tines and small beam fragments. Antler bases, the most robust part of the element, are most frequently encountered. Five isolated reindeer teeth were excavated as individual finds from the palaeochannel deposits, together with 26 postcranial elements. Only two of the latter were complete, a well-preserved left metacarpal (50869) and a gnawed second phalanx (50212). *C. antiquitatis* is the next most common taxon, with

Fig 5.22 (above)
Tusks of Mammuthus primigenius *in the main palaeochannel during excavation.*

Fig 5.23
Proximal L radius of Mammuthus primigenius *(51903), posterior view (scale in mm).*

Fig 5.24
Proximal R ulna of Mammuthus primigenius *(51976), anterior view (scale in cm).*

14 remains representing two adults and two juveniles (1 per cent of the assemblage). Again, the more durable elements such as teeth and robust postcranial elements like distal humeri are best represented. Numbers of *E. ferus* are also low, and with the exception of three elements from the hind limb, consist exclusively of teeth. Two adults are represented by the excavated finds, although a juvenile animal is recorded in the wet-sieved spit residues on the basis of a deciduous lower second tooth. Bison is the least abundant taxon with only three postcranial elements represented, two of which are durable distal humerus fragments. A minimum number of two adults is implied (*see* Table 5.2). Carnivores, although usually scarce in assemblages from open sites, are comparatively well represented at Lynford, with predominantly dental elements preserved. Four taxa have been recorded, each represented by a minimum of one individual.

Results from the bulk samples and sieved spit residues

Remains extracted from the bulk sample residues are shown in Appendix 3, Table 1. In addition to the serial samples taken for microvertebrates, bones and teeth were also recovered from 21 bulk samples taken for molluscan remains (Keen, chapter 3). In total, 2040 fragments were recorded, ranging from large tusk or cranial fragments of *M. primigenius* to small vertebrate remains, including fish, herpetofauna and occasional small mammal remains. In the large bone fraction, the samples were dominated by mammoth tusk fragments (345 specimens), followed by indeterminate bone fragments, most probably also of mammoth (284 specimens), and mammoth cranial fragments (131 specimens). Three fragments of molar plate of *M. primigenius* were also noted.

In the smaller fraction, indeterminate bone fragments were most commonly encountered (710 specimens, 35 per cent of the smaller fraction). These were generally less than 5mm in diameter and consisted mainly of very comminuted fragments of larger bones. In the identifiable small vertebrate fraction (468 specimens), remains of fish dominated (376 specimens), particularly spines and vertebrae of three-spined stickleback (*Gasterosteus aculeatus*), with smaller numbers of perch (*Perca fluviatilis*), rare remains of pike (*Esox lucius*) and a single find of a cyprinid. The fish remains are uniformly well preserved and include particularly fragile elements such as perch scales and a cyprinid pharyngeal bone with the teeth still *in situ*, attesting to the gentle depositional environment. Herpetofaunal remains are the next most common elements (Gleed-Owen, this chapter), with 82 specimens from one species, but mammalian remains are comparatively rare. Only eight molars or molar fragments and incisors can be attributed to *Microtus* sp. or to Microtinae, and no other identifiable small mammal remains were recorded. Ninety-nine small vertebrate long-bone fragments lacking articular ends were also extracted from the samples. These do not have the distinctive hollow diaphyses and flaring morphology of herpetofaunal long-bones and are therefore most probably the postcranial remains of small mammals. However, the state of degradation in these long-bone fragments makes them impossible to identify further. Without exception, the bones are crushed and longitudinally split, suggesting that they have been subject to weathering or pressure, probably from trampling, prior to their incorporation in the deposits.

The herpetofaunal remains are similarly poorly preserved, even though they are a relatively more autochthonous component of the deposits than the mammalian remains (Gleed-Owen, this chapter).

In terms of faunal representation relative to sampling position within the channel, no discernible difference could be detected between the various column series. This would suggest that in such a shallow-water environment, distance from the channel margin has not been a significant factor in influencing either preservation or the relative abundance of the different taxa. Mammalian remains, which one would expect to find in greater abundance near the channel edge, are rare in all cases. Similarly, the column samples provide no clear indication of faunal change up through the sequence. Indications of periods of overbank flooding are present in the molluscan assemblage (Keen, chapter 5), illustrated by the influx of higher numbers of terrestrial taxa, but no such patterns are discernible in the vertebrate record. Only the decrease in fish remains in the highest samples of series 30.198, 30.225, 30.226 and 30.234 hints at a period of drying-out, although the paucity of vertebrate remains in general in these samples might equally point to weathering of the uppermost deposits.

Remains extracted from the wet- and dry-sieved spit residues are shown in Appendix 3, Tables 2 and 3. The dry-sieved fraction yielded 26423 fragments (combined weight 28.04kg after sieving), predominantly of tusk and cranium of *M. primigenius* (Appendix 3, Table 2). The yield of the samples varied from single finds to over 500 small fragments in a single bag. Indeterminate bone fragments are well represented and only a single sample (64236) yielded remains of any large mammal species other than mammoths, in this instance a left lower third incisor of *E. ferus*. The dry-sieved residues were very poor in the remains of small vertebrates. No small mammal remains were recovered, and the only specimens recorded were six herpetofaunal bones (62278, 62280, 62406, 62425, 62667 and 64504), three fish bones (61959, 62410, 62667) and a single find of a bird bone (61276, a proximal left tarsometatarsus of a crake [*Porzana* sp.], identified by Dr Joanne Cooper, Natural History Museum, London).

The wet-sieved spit residues (Appendix 3, Table 3) yielded 17660 specimens (combined weight 10.36kg after sieving) from a much wider range of taxa than were observed in the dry-sieved material. Both dry- and wet-sieved spits were sieved through the same mesh sizes on site but the greater range of material extracted from the latter implies that the cleaned residues were easier to scan, resulting in a higher yield of fragments and a concomitantly greater species diversity. As with the dry-sieved residues, the samples were dominated by indeterminate bone fragments, mammoth cranial fragments and tusk. However, in contrast to the dry-sieved residues, a much wider range of other large mammals was encountered (cf *C. lupus*, *E. ferus*, *C. antiquitatis*, *R. tarandus* and Bovidae sp.). These mammals were represented by teeth and tooth fragments, and small vertebrates were also recovered, although in substantially fewer numbers than in the wet-sieved bulk samples; again, a likely reflection of processing methods as the bulk samples were sieved to 500µm under laboratory conditions, and the spit residues sieved to 6mm on site. Of the identified fish material, spines of *G. aculeatus* were most abundant (nine specimens), followed by teeth of *E. lucius* (six specimens) and scales of *P. fluviatilis* (two specimens). Undetermined fish bone fragments numbered 42. In the small mammal assemblage, five molars of *M. gregalis* and two teeth of *Spermophilus* sp. were noted, together with 24 specimens, molar fragments and incisors, of *Microtus* sp. and indeterminate Microtinae. As in the other spit and bulk residues, the small vertebrate long-bones were uniformly split, crushed and lacking epiphyseal ends. One bird bone was present, a distal right tarsometatarsus (61634), also of crake (J. Cooper, pers comm). Although the morphology of both crake specimens reliably allows classification to genus, they are too fragmentary to be confidently referred to a species as the remains fall into the overlapping size range of several small crakes; the spotted crake *Porzana porzana* (L.), the little crake *Porzana parva* (Scopoli) and Baillon's crake *Porzana pusilla* (Pallas).

Taphonomy

A comprehensive study of the taphonomy of the Lynford vertebrate assemblage was undertaken, involving the integration of the sedimentary history at the site with the vertebrate evidence

Fig 5.25 (opposite) Distribution of individual vertebrate finds within the main palaeochannel.

in order to understand how the assemblage was formed. The preservation potential of bone is dependent on a number of characteristics including size, shape, composition and other physical attributes. Large bones are less susceptible to transportation by normal current velocities and less vulnerable to complete destruction by predators or by weathering or trampling. The composition of individual elements is also significant, in particular the ratio of spongy to compact bone (S/C ratio). The spongy bone present in the epiphyseal ends of long-bones is particularly attractive to carnivores such as *C. crocuta* (Haynes 1980) and will therefore be preferentially destroyed, leaving only the diaphyses. The spongy epiphyseal bone is also more friable than the compact bone of the midshafts, and is therefore less likely to be preserved. Teeth, in contrast, tend to preserve well because of their small size, low S/C ratio and dense enamel and dentine composition. The surface area to volume ratio (SA/V) also has a bearing on the survivability and transportation potential of different skeletal elements. Bones with a high SA/V, such as scapulae and innominates, tend to be thin and flat and are therefore more susceptible to general breakage and to carnivore damage (because the marrow cavity can be readily accessed) (Shipman 1981). These elements are also more prone to hydrodynamic dispersal as their greater surface area enhances the potential for drag and suspension by a water body. All of the above factors have potentially influenced the formation process of the Lynford assemblage.

For each species it was therefore established which skeletal elements were present at the site, their degree of completeness and their distribution within the channel. The condition of the material was also assessed in detail, involving (1) examination of the bone surface for evidence of rolling and abrasion in order to determine whether parts of the assemblage have been transported by water action, (2) inspection for root etching, weathering or polishing that might indicate prolonged exposure prior to burial, (3) examination for signs of trampling or crushing by large mammals, and (4) assessment of evidence for accumulation or modification by hominins, carnivores or other agents (eg cutmarks, deliberate bone breakage, carnivore or rodent gnawmarks or digestion).

Orientation of the bones within the palaeochannel and the nature of the depositional environment from the vertebrate assemblage

The vertebrate material is aligned in a broad east-north-east to west-south-west direction, according to the course of the palaeochannel (Boismier, chapter 4), but the bones themselves show no discernible preferred orientation within the deposits from examination of the plans (long-axis orientation and the angle of dip of the bones were not measured during the excavation, although all excavated elements were drawn in plan view). The distribution of the vertebrate remains is shown in Fig 5.25. This would initially suggest that very little dispersal or sorting of the bones had occurred once they had been deposited in the channel, although no articulated remains were recovered. However, in order to further assess whether fluvial activity had played any part in sorting the material, the assemblage was compared with the three groups of skeletal elements defined by Voorhies (1969). These groupings indicate which skeletal elements are most likely to be transported and deposited together by hydraulic action, thereby allowing the degree of preferential sorting to be calculated (Table 5.11). Elements that are likely to be removed immediately by water action (Group I), even by low-velocity currents, include ribs, vertebrae, sacrum and sternum. These elements are generally long and thin or have a relatively complex structure, giving them a high SA/V ratio. They are also comparatively fragile, with a high S/C ratio, and are thus more vulnerable to transportation. At the other end of the spectrum (Group III) are those compact and/or massive elements that can only be transported by high-velocity currents. These include crania and mandibles, both of which have a low SA/V ratio and a low S/C ratio (Voorhies 1969; Shipman 1981). The major limb bones occupy intermediate positions between these two groups. An assemblage containing all three Voorhies groups is probably underived or transported and is therefore considered to be an appropriate subject for palaeoecological reconstruction (Shipman 1981).

Of the individually numbered finds from Lynford, 624 can be categorised according to the Voorhies groups. Examination of the distribution of the different elements reveals that 30 per cent of the 624 finds can be assigned to Group I and 62 per cent to Group III.

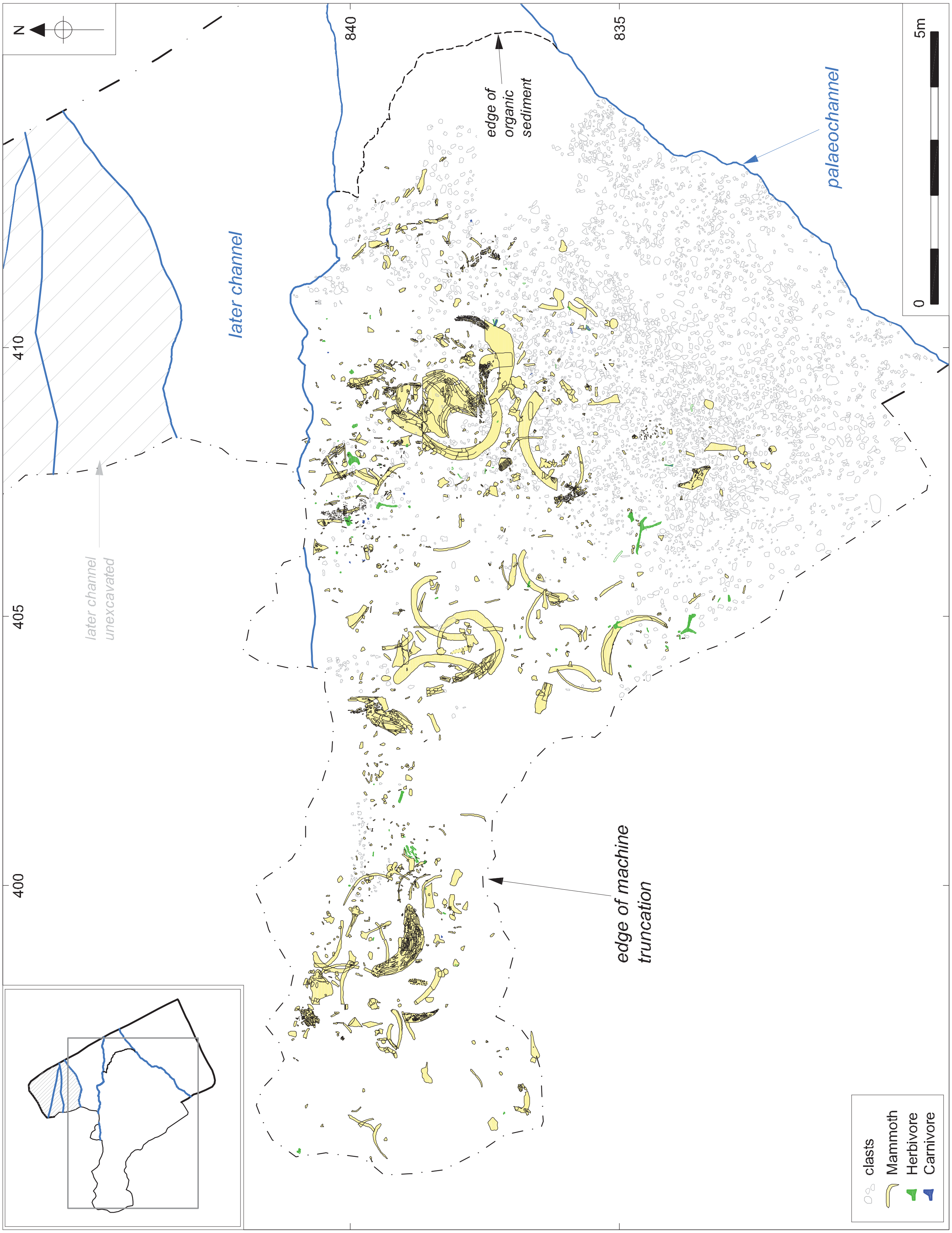

N
840
835
410
405
400
later channel
later channel unexcavated
edge of organic sediment
palaeochannel
edge of machine truncation
0
5m
clasts
Mammoth
Herbivore
Carnivore

Fig 5.26 (opposite) Distribution of refitting and associated vertebrate finds within the main palaeochannel.

Table 5.11 Potential of different bones for dispersal by water according to Voorhies Groups, compared to body part representation at Lynford

Voorhies Group I: bones immediately removed by low velocity currents; high SAV ratio; high S/C ratio

element	*count*
ribs	132
vertebrae	30
sacrum	0
sternum	4

intermediate between I and II

element	*count*
scapula	4
phalanges	4
ulna	5

Voorhies Group II: bones removed gradually by moderate currents; low SA/V ratio; intermediate S/C ratio

element	*count*
femur	13
tibia	9
humerus	12
metapodials	–
pelvis	–
radius	–

intermediate between II and III

element	*count*
mand. ramus	23

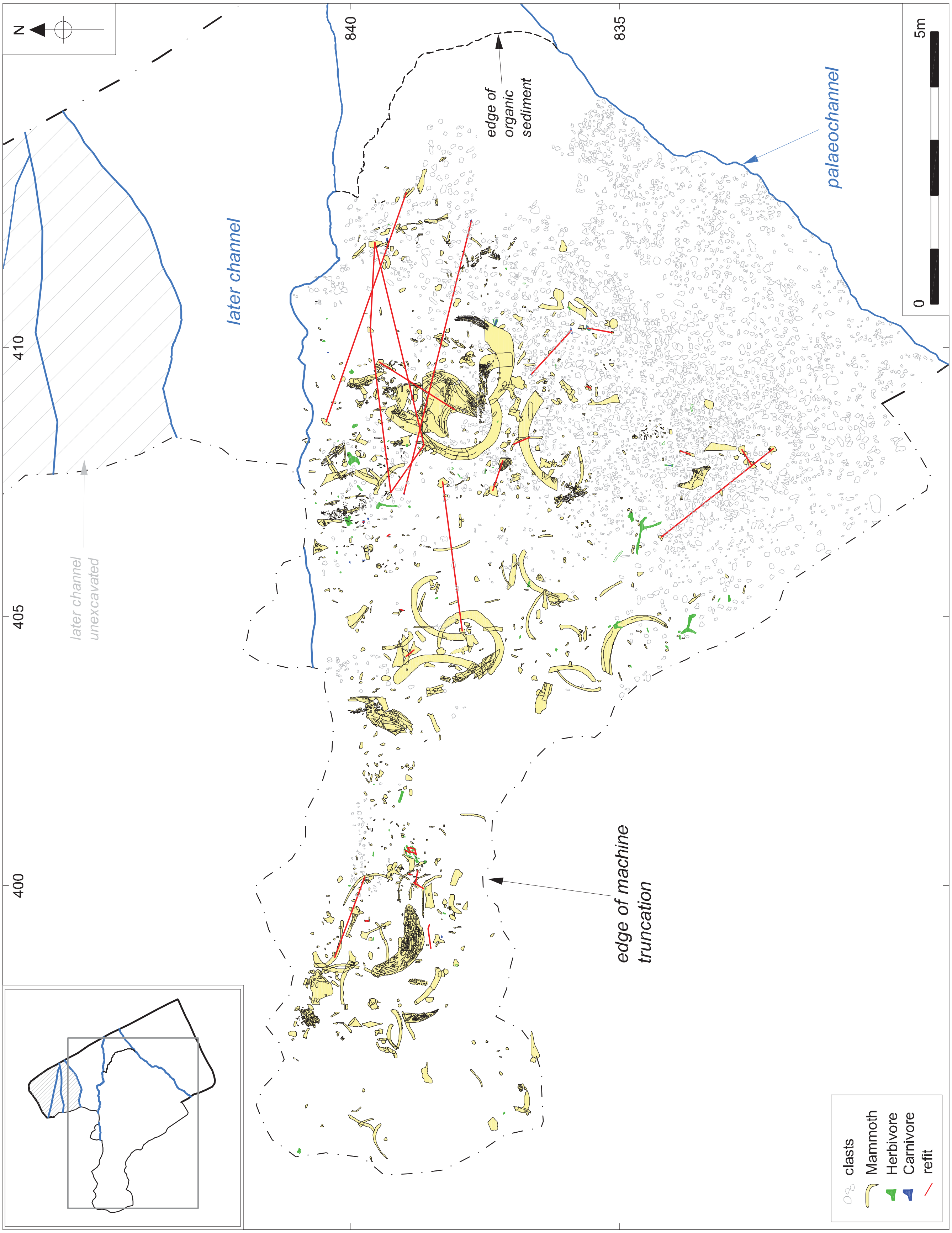
Voorhies Group III: lag deposit moved only by high-velocity currents; low SA/V ratio; low S/C ratio

element	*count*
skull	380
mandible	8

Even taking into account the higher proportion of friable cranial fragments, this would imply that there has been little disturbance of the assemblage by fluvial activity following its deposition. This is supported by the presence of elements such as complete vertebrae with intact neural spines in the large mammal fraction, and by elements such as delicate fish scales in the microvertebrate assemblage.

However, a number of refitting bone and tooth fragments with old breaks and rearticulating elements have been noted in the assemblage. Specimens with fresh breaks caused by excavation damage are excluded, as are specimens apparently from the same element with consecutive finds numbers and conjoining fragments within the same finds bag. These refits occur across all parts of the site and are not concentrated in a single area, as is the case with the refitting lithics (White, this chapter). The refitting elements include mammoth rib fragments (50184 and 50151; 51259 and 51262; 51448 and 51451; 51972 and 51999), mammoth cranial and maxillary fragments (51038 and 51619), a mammoth R m3 (51154, 51648 and 51953), a mammoth atlas vertebra (51515 and 51537) two fragments of a wolf ulna (50233 and 51860) and wolf dentary (51218 and 51223) and an astragalus and calcaneum of horse (51831 and 51869). The greatest distance between refitting elements is 4.49m (Fig 5.26). All the refits noted occur in the organic sediments of Unit B-ii:03, with the exception of the mammoth cranial fragments and maxilla, which were found in the sands of Unit B-ii:01 (20364 and 20384 respectively). Carcasses lying on the adjacent land surface prior to incorporation in the channel would have been disarticulated, dispersed and broken by various agents, including large herbivores, carnivores and, possibly, Neanderthals. It is therefore not possible to determine whether the remains were broken on the land surface or once they had been deposited in the channel sediments. Either way, bioturbation from the trampling activities of large mammals around the edge of the channel or in the water body itself are likely to be the primary cause of these breakages and dispersals. Parallels have been noted within the insect assemblage from Lynford, where a high proportion of remains in the palaeochannel are fragmented (Coope, chapter 3).

The absence of evidence of transportation or winnowing of the assemblage means that palaeoecological reconstructions based on the mammalian remains can be undertaken with a good degree of certainty that the animals represented at the site inhabited the local area, a point highlighted by the abundance of dung beetles in the channel deposits (Coope, chapter 3). The spatial distribution of the finds within the channel gives no clue as to hominin activities within the channel itself, since there are no apparent concentrations of particular body elements in certain areas. The edge of the


N
840
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edge of organic sediment
palaeochannel
later channel
410
405
400
later channel unexcavated
edge of machine truncation
clasts
Mammoth
Herbivore
Carnivore
refit

channel, where butchering and consumption activities might have left a noticeable pattern, is unfortunately not preserved.

Size of the individual finds

It was apparent from the outset that extraordinarily little complete material was present in the assemblage. The majority of the 55 isolated teeth recovered during the excavation were in a perfect or near-perfect state but, as stated above, the cranial and postcranial specimens were almost all fragmentary. Robust elements, such as the large limb bones of mammoths, are generally considered to be less susceptible to breakage than those with a long slender form such as ribs. However, this is not the case at Lynford where more complete mammoth ribs than long-bones survive. Crania characteristically fracture along the sutral lines (Kos 2003), but while the abundance of cranial fragments in the assemblage is not particularly surprising, the degree of further fragmentation in these cranial elements is noteworthy. Analysis of the degree of fragmentation in the assemblage might provide some measure of the destructive forces to which the Lynford assemblage was exposed, both before and after burial. In the majority of cases, bones will be broken by the natural processes of decay, weathering, the actions of predators, fluvial transportation, trampling and diagenesis, including compaction by the overlying sediments.

The broken and irregular nature of the Lynford material dictated the methods chosen to analyse the size of the individual specimens and a system of six concentric circles, drawn on card, was accordingly devised, against which each find was measured. The diameters of the circles increased in 30mm stages (Class 1: 0–30mm; Class 2: 30–60mm; Class 3: 60–90mm; Class 4: 90–120mm; Class 5: 120–150mm and Class 6: > 150mm). A total of 2022 specimens were measured. In cases where more than one fragment was present in the finds bag, the measurement was taken on the largest fragment present in order to gauge the minimum amount of breakage that the specimen had been subjected to. This also allowed for further post-excavation damage to be discounted. The following results were obtained: Class 1: 212 specimens (approximately 11 per cent of the measured assemblage); Class 2: 748 specimens (37 per cent); Class 3: 506 specimens (25 per cent); Class 4: 208 specimens (10 per cent); Class 5: 119 specimens (6 per cent) and Class 6: 229 specimens (11 per cent). The relative abundances of each size class are shown in Fig 5.27. Since so few elements are complete, the high degree of fragmentation in the assemblage is immediately obvious. Over 72 per cent of the measurable specimens are under 90mm in diameter, and only 11 per cent fall within the largest size category of 150mm and above.

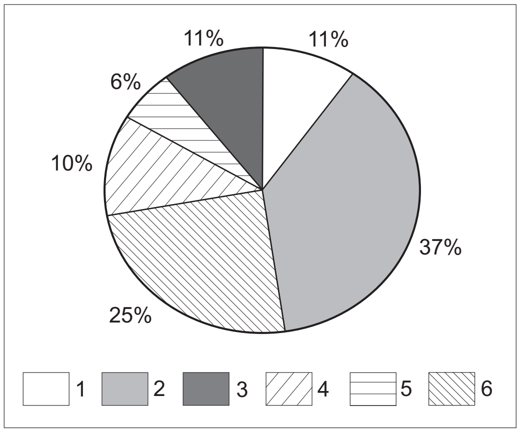

Fig 5.27
Pie chart showing the relative frequency of finds according to size class (1 = 0–30mm diameter; 2 = 30–60mm; 3 = 60–90mm; 4 = 90–120mm; 5 = 120–150mm; 6 = >150mm).

Given the apparent lack of fluvial transportation, the extreme fragmentation of the material must be attributed to other agents. The activities of predators are likely to have played a significant role in disarticulating and dispersing carcasses in the vicinity of the channel and then in the selective destruction of some skeletal elements. Carnivore gnawing tends to reduce long bones first to cylindrical shafts, and then to bone splinters (Binford 1983). This might account for some of the shards of mammoth long bone observed in the assemblage. However, it is the trampling activities of large mammals that are considered here to have amplified the degree of bone breakage. The trampling of bones near a water source is a common occurrence, particularly by herds of ungulates coming to drink – a scenario that seems likely to have occurred around the channel at Lynford. The effects of trampling on large mammal bones have been documented in detail by Andrews and Cook (1985) and Behrensmeyer *et al* (1986). These include not only fragmentation of the bones, but also a wide range of surface modifications such as scratches, gouges, scrapes and cuts, some of which might superficially resemble the butchery marks left by flint tools. The greater the degree of weathering of the material, the more fragmentation is likely to occur, and only the smallest and most dense elements will survive. The inferred post-depositional compaction of the main channel sediments by 33 per cent (Tovey, chapter 3) is also likely to have contributed to the further fragmentation of the material and to the crushing that is apparent on many of the larger specimens, which were recovered using plaster jackets. In addition, the subsequent quarrying activities and pressure from heavy machinery could have further deformed the bones and sediments.

Experiments carried out on trampling of small mammal bones (Andrews 1990) revealed patterns of breakage on all elements, resulting in a complete absence of crania, a reduction in the number of maxillae, a high proportion of isolated teeth, the considerable breakage of larger postcranial elements and some degree of loss, but no loss or breakage in the smaller elements. The allochthonous component of the Lynford small vertebrate assemblage (the mammalian and avian remains) are very few in number, but their generally poor condition, typified by split and broken long-bones, potentially reflects trampling and/or weathering action on the land surface adjacent to the channel.

Condition of the vertebrate assemblage

The condition of the vertebrate assemblage was examined in detail, including the degree of weathering, and evidence of abrasion and root damage, in order to assess the depositional history of the material, particularly relating to questions of hydraulic transportation and rapidity of burial. Bones from the main channel infill (B-ii:03) are generally stained mid- to dark-brown in colour, and a pale grey-white ‘bloom’ occurs on some specimens, possibly a post-excavation microbial growth. Teeth from B-ii:03 are stained dark grey-blue in colour. Bone stained to varying intensities of orange, the result of iron oxides in the depositional environment, is also common. Occasionally, specimens have been only partially stained, for example on one surface only, or along half their length.

The degree of weathering observed in a bone can reveal information about the rapidity of burial. Weathering is the consequence of exposure to the elements prior to deposition, the result of the physical agents of wind, sun, rain and temperature change that will ultimately destroy the skeletal elements if they are not buried. Six categories of weathering were identified for large mammal bones under tropical climatic conditions by Behrensmeyer (1978) and four categories for small mammal bones under wet temperate climatic conditions by Andrews (1990). These are shown in Table 5.12. The surface of all individually numbered bones in the Lynford assemblage was examined, and each assigned to one of the weathering categories established by Behrensmeyer (1978). The small vertebrate bones from the bulk samples and sieved spit residues were not considered individually but by Class (Mammalia, Amphibia etc).

A total of 2090 specimens were analysed, including all unstratified and un-numbered finds. Of these, no specimens were found for Class 0, 24 specimens (1 per cent) were attributed to Behrensmeyer’s Class 1, 299 (14 per cent) to Class 2, 1192 (57 per cent) to Class 3, 419 (20 per cent) to Class 4 and 156 (8 per cent) to Class 5. The predominant category is therefore that of bones that are estimated to have been exposed on the surface for between 4 and 15 years or more before burial (Class 3), followed by material exposed for between 6 and 15 years or more (Class 4). Seriously weathered material with a characteristic flaking ‘onion peel’ texture, and occasionally exposed cancellous bone, accounts for 8 per cent (Class 5). Only 1 per cent of the material was considered to be sufficiently well preserved to have been buried less than four years after the death of the animal, the majority of which is dental remains, and therefore less susceptible to degradation in any case. A greater number, 14 per cent (Class 2), however, indicate exposure of material for between two and seven years before burial. Material from the different classes is evenly distributed in the sediments of the main palaeochannel, although the most weathered specimens come from the sands overlying the black organic sediments. It is important to bear in mind, however, that the figures given for years of exposure are an indication only, since bones that are exposed in hot or humid climates, as in Behrensmeyer’s original study, will be destroyed through weathering more rapidly than in cool climates. Under the climatic regime inferred for Lynford (mean July temperature 12–14°C and mean January/February temperatures at or below –10°C), bones might have remained relatively well preserved for longer. The inferred exposure rates prior to burial should therefore be viewed as minimum estimates only.

Table 5.12 Weathering categories for large mammal bones (after Behrensmeyer 1978) and small mammal bones (after Andrews 1990) and inferred length of exposure in years before burial

stage	*large mammal bone weathering categories (after Behrensmeyer 1978)*	*years since death*	*small mammal bone weathering categories (after Andrews 1990)*	*years since death*
0	no cracking or flaking; greasy; soft tissue still present; marrow contains tissue	0–1	no modification	0–2
1	longitudinal cracking parallel to fibre structure in long bones; shiny and smooth surface; fat, skin and other tissues may or may not be present	0–4	slight splitting of bone parallel to fibre structure; chipping of teeth and splitting of dentine	1–5
2	flaking of outer surface usually associated with cracks; flakes long and thin with one end attached to bone; edges of cracks angular on cross-section; exfoliation begins; remnants of soft tissue may still be present	2–7	more extensive splitting but little flaking; chipping and splitting of teeth leading to loss of parts of crown	3–5+
3	bone surface rough with fibrous texture; weathering penetrates 1–1.5mm; tissue rarely present	4–15+	deep splitting and some loss of deep segments or 'flakes' between splits; extensive splitting of teeth	4–5+
4	bone surface rough and coarsely fibrous; splinters of bone loose on surface; weathering penetrates inner cavities; cracks open with splintered or rounded edges	6–15+		
5	bone very fragile and mechanically falling apart; large splinters present; cancellous bone exposed	6–15+		

The evidence of prolonged exposure of most of the skeletal material on the surface prior to burial might account for the paucity of beetle species normally associated with dried carcasses, such as the Dermestidae (Coope chapter 3). These beetles would have utilised the carcasses and departed from the scene long before the bones became incorporated in the main palaeochannel. Therefore, although the coleopteran assemblage (notably the high proportion of dung beetles) provides a clear indication of the presence of large mammals in the vicinity of the channel at the time of its infilling, it does not reveal evidence of the presence of dried carcasses. The absence of species feeding on the dried periosteum of old bones is therefore puzzling, since the degree of weathering of the bones clearly indicates that such material was available in abundance. In the case of the better-preserved bones, the selective removal of limb bones, and the covering of the carcasses by water, would likely have prevented the colonisation of the flesh by fly larvae, thereby accounting for the absence of puparia.

Signs of abrasion were noted on 44 specimens (2.15 per cent of the assemblage). Abrasion, which can be generated either by hydraulic or aeolian activity, is manifested by the rounding of normally distinct anatomical features such as ridges or muscle scars, by the wearing of broken edges, by pitting of the bone surface and occasionally by polishing of the surface. Severe abrasion can also ultimately remove the bone surface (Shipman 1981). Three broad categories of abrasion have been identified by Shipman (1977): (1) little or no abrasion – fresh, sharp edges or breaks; (2) moderate abrasion – some rounding of edges or breaks, and (3) heavy abrasion – edges obscured, breaks well rounded, surface bone possibly missing. Although the classification is coarse and the observations subjective, only three specimens within the Lynford abraded fraction were deemed to show heavy abrasion (Category 3), whereas the remainder are only moderately abraded (Category 2). With the exception of five specimens, two unstratified finds, a single find from context 20051 (unit B-i:03) – an orange gravel immediately below the main palaeochannel – a single find from an unspecified context and a single find from 20005 (unit B-ii:05) – a laminated sand deposit filling a scour feature above the main palaeochannel – all of the abraded material is from the infill of the channel itself. The number and distribution of abraded specimens are shown in Table 5.13.

Within the channel infill, ten abraded specimens come from sand and gravel contexts, where a degree of abrasion would be anticipated, but a further 29 come from the dark brown-black organic sands of contexts 20003 and 20021 (B-ii:03). The presence of abraded remains within these finer-grained contexts indicates that a small amount of material has most probably been transported into the channel by fluvial activity, although abrasion by wind cannot be ruled out. This would appear to confirm the minimal fluvial influence inferred from the orientation and body-part representation studies. Two specimens show an unusual degree of polishing. Specimen 50162 (a diaphyseal fragment of reindeer humerus) has a highly polished surface although the cause of this has not been determined. Specimen 51240, a R M1 of *M. primigenius*, also displays unusual polishing on parts of the occlusal surface and posterior lingual margin, with apparent resorption of the dentine (Figs 5.28 and 5.29). This is considered to be the natural result of the animal rubbing the tooth and the gum area, as opposed to the result of aeolian or other action (AP Currant, pers comm).

Root damage, in the form of an acid-etched tracery of fine lines on the surface of the bone, was noted on 11 specimens (0.05 per cent of the assemblage). The presence of root etching indicates that the bones were not buried immediately after death, but were exposed on a land surface long enough for the bone surface to be exploited by the root systems of local plants. This also has implications for the inferred palaeoenvironment, since it indicates the development of terrestrial vegetation in the vicinity. Of the affected material, ten specimens come from the main fill of the palaeochannel (eight from 20003 and two from 20248 [both B-ii:03]), and one was unstratified (20048). Although the presence of root damage indicates delayed burial, it does not correspond directly to the degree of weathering observed, presumably because in some cases the vegetation cover might offer protection from the elements. Of the root-damaged specimens, one specimen was classified as Condition Group 2, six as Condition Group 3, two as Condition Group 4 and two as Condition Group 5.

Table 5.13 Number and distribution of abraded specimens according to context

facies	*context*	*no. of abraded specimens*
B-i:03	20051	1
B-ii:01	20254	2
B-ii:01	20369	3
B-ii:01	20384	1
B-ii:03	20003	27
B-ii:03	20021	2
B-ii:03	20022	1
B-ii:04	20132	1
B-ii:04	20247	1
B-ii:04	20367	1
B-ii:04	20374	1
B-ii:05	20005	1

Fig 5.28
R M1 of Mammuthus primigenius *(51240), showing polishing along lingual margin, occlusal view (scale in mm).*

Fig 5.29
R M1 of Mammuthus primigenius *(51240), showing polishing along lingual margin, lingual view (scale in mm).*

Modification of the bones by carnivores, rodents and non-mammalian predators

All bones within the assemblage were scrutinised for evidence of modification by non-hominin agents, most notably carnivores, cervids, rodents, avian predators and insects. The occurrence of gnawmarks indicates not only indicates that bones have been exposed prior to burial, but can also shed light on the modifying species in terms of preferred prey or population density. Bones that have been gnawed by carnivores, in particular by the spotted hyaena, are frequent finds in Pleistocene sediments in caves, often where the animals have been denning. Carnivore gnawing is manifested by a number of features, most commonly pitting puncture marks from canines, striations of the internal and external bone surfaces, 'scalloping' of the broken edges and the cracking open of bones to extract marrow. Certain skeletal elements, for example the neural spines of vertebrae and the foot bones of non-ungulate mammals, may be preferentially destroyed (Shipman 1981), as might the epiphyseal ends of long-bones. In the most extreme cases, bone-chewing specialists such as *C. crocuta* will swallow and partially digest bones, rendering even large bones unrecognisable in a few days (Kruuk 1972).

Fig 5.30
Second phalanx of Mammuthus primigenius *(50733), showing carnivore puncture mark near proximal end, lateral view (scale in mm).*

Fig 5.31
First phalanx of Rangifer tarandus *(50212), showing carnivore puncture mark near proximal end, lateral view (scale in mm).*

Within the Lynford mammalian assemblage, 67 specimens (0.03 per cent of the assemblage) show evidence of carnivore modification. These remains are predominantly of *M. primigenius* (43 specimens), with smaller numbers of *R. tarandus* (eight specimens), C. antiquitatis (two specimens) and E. ferus (one specimen). The remaining 21 specimens are of undetermined taxa. Large long-bones, ribs, cranial elements and phalanges are most commonly affected. In cases where the modifying agent has been identified, the spotted hyaena appears to be the most likely culprit. This is particularly interesting, since only a single tooth fragment and a second phalanx of this species have been recovered from the site, together with two putative coprolites. A number of bones show clear puncture marks and depression fractures created by the piercing action of canine teeth, for example a second phalanx of *M. primigenius* (50733, Fig 5.30) and a second phalanx of *R. tarandus* (50212, Fig 5.31). In several cases, large limb elements of mammoths, including femora, humeri and tibiae, have had their epiphyses completely destroyed and the surviving diaphyses display characteristic scalloped edges and scratches. In others, the bones have been split longitudinally and the greasy interior cancellous bone attacked (eg 50004, a right humerus midshaft of *M. primigenius* that has deep grooves and gouges on its internal surface).

Although it cannot be ascertained what percentage of the gnawed bones came from animals killed by spotted hyaenas, scavenged from the kills of other predators or dead of natural causes, it is interesting to note that two specimens, a distal diaphyseal portion of a left humerus of M. primigenius (51885) and a tibia midshaft of *C. antiquitatis* (51372,

Fig 5.32 (top left) Tibia diaphysis of juvenile Coelodonta antiquitatis *(51374), heavily gnawed by spotted hyaena, anterior view (scale in mm).*

Fig 5.32), both belong to juvenile animals that would have been more vulnerable to predation than the adults. In the latter case, both epiphyseal ends are missing, and the specimen has been reduced to little more than a ring of diaphyseal bone. Similar finds of gnawed and partially digested woolly rhinoceros material are known from the Middle Devensian cave deposits of Kent's Cavern, near Torquay, Devon. A R dp2 of *R. tarandus*, (50795, Fig 5.33) also from a juvenile animal, and a second phalanx of *C. crocuta* (spit sample 60726, *see* Fig 5.4) have been partially digested, almost certainly the result of being swallowed by a spotted hyaena. Cases of hyaenas consuming their own kind have been noted at other British Pleistocene sites, for example Tornewton Cave in Devon (Currant in Roberts 1996). Although remains of two other large carnivores – wolf and brown bear – are also present in the assemblage, neither of these species have the ability to crack open bones and to consume them in the manner of spotted hyaenas. The evidence from the gnawed fraction of the assemblage highlights the fact that these elements were not buried immediately, but remained exposed on the surface for some time, perhaps weeks or even years in the case of the most heavily-gnawed specimens.

Four specimens – two rib fragments and two indeterminate bone fragments – show evidence of gnawing by rodents, in the form of small, slanting, parallel grooves. The small vertebrate material from the bulk and sieved spit samples was also examined for signs of digestion, in the form of pitting or corrosion, by avian predators. Two first lower molars of *Microtus gregalis* (61096 and 63646) possess slightly rounded salient angles and are partially eroded, suggesting light digestion. Although it is sometimes possible to identify the agent of accumulation from the degree of corrosion and breakage observed (Andrews 1990), the assemblage is too small to establish this at Lynford.

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