REMAINS OF MAMMALS FROM THE DARENT RIVER GRAVELS AT SEVENOAKS RESERVE, KENT

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INTRODUCTION

Since 1975 fossil and recent remains of mammals found at Redlands Pit, near Sevenoaks, Kent, have been systematically preserved in the Harrison Zoological Museum and studied by the authors. The gravel workings and surrounding areas have been developed as a Nature Reserve in recent years by Dr. Jeffery Harrison and his enthusiastic helpers in co-operation with the Wildfowlers Association of Great Britain and Ireland and the Wildfowl Trust. The recent mammals of the area were surveyed by Harrison.[1]

The area concerned (Plate IA) is situated in the Darent River Valley in the Vale of Holmsdale, south of the scarp face of the North Downs and situated north of Bradbourne Vale Road, west of the Sevenoaks–Otford Road and south of the new M26 Motorway (Fig. 1, sketch map). Geological maps of the area[2] show the presence of a limited river gravel deposit in this area, forming a terrace along the course of the Darent (Fig. 2) and lying on the gault. It is this drift deposit, composed largely of angular flints derived from the escarpments, which has been commercially extracted by Redlands Ltd. for a number of years. The faunal remains studied have been derived from two separate areas desig-

[1] D.L. Harrison 'A Mammal Survey of the Sevenoaks Reserve and Darent Valley', in J.G. Harrison *The Sevenoaks Gravel Pit Reserve,* WAGBI Conservation Publication, 1974, 97–9.

[2] H.G. Dines, S. Buchan, S.C.A. Homes and C.R. Bristow, 'Geology of the Country around Sevenoaks And Tonbridge', *Mem. Geol. Survey Gt. Britain,* HMSO, 1969, 1–183.

PLATE IA

(Photo. P.F. Harrison)

A general View of the northern Boundary of Excavation Site I, looking towards the new M26 Motorway.

PLATE IB

(Photo. P.F. Harrison)

Stratigraphy at the northern Boundary of Excavation Site I, in the same Area as Plate IA.

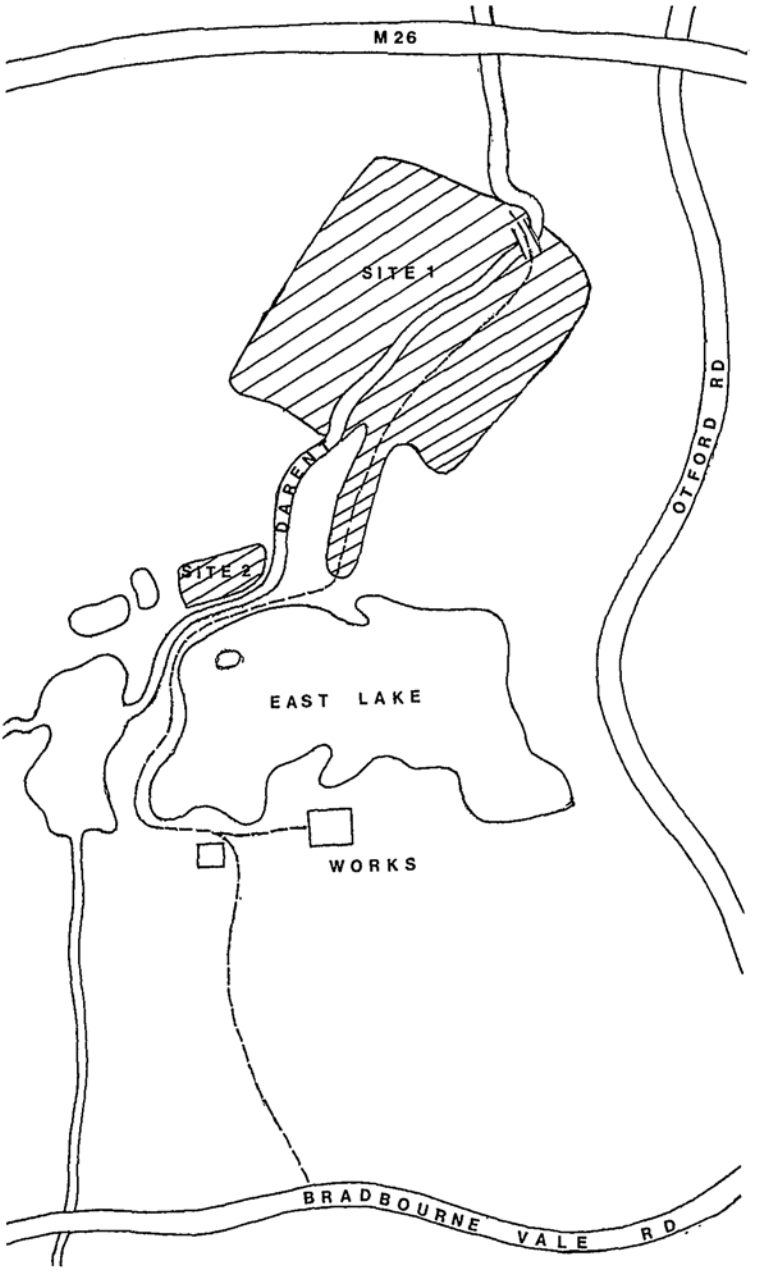


Fig. 1. The Sevenoaks Reserve, showing the two Sites from which Fossil Bones have been extracted 1975–1980. N.B. Not strictly to scale.

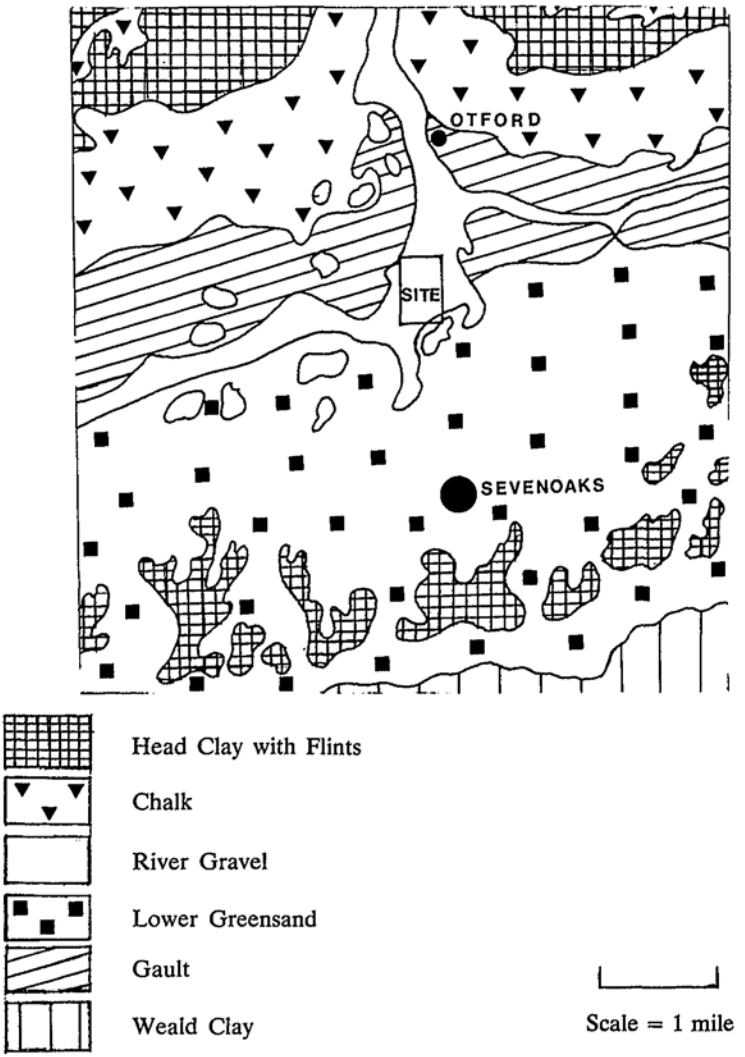


Fig. 2. Site of the Sevenoaks Reserve in Relation to local Geological Deposits. Adapted from Dines *et al.*[2]

nated Sites I and II (see Fig. 1) from which the gravel has been extracted as a 'dry' working (i.e., not from the bottom of a deep lake as formerly done in the large West and East lakes shown in Fig. 1, from both of which gravel was extracted in the past). The stratigraphy of the area is shown in Plate IB, a section at the northern side of the northern area of excavation, Site I in Fig. 1, near the new M26 Motorway. The depth of the layer of river gravels varies in different parts of the pit from about 1 m. to about 6 m., with a covering of surface soil about 0.6–1.2 m. in thickness and underlain by the Blue Cretaceous Gault, a grey, sticky, plasticene-like clay, containing marine invertebrate fossils, and which dries out to form a grey powdery material. The method of extraction employed is important, determining the way most of the animal bones are recovered. Extraction is by means of a crane-operated bucket dragged upwards from the pit bottom and depositing about a ton weight at a time into lorries, which transport the mixed extract to a washing plant, south of the East Lake. Here it is fed into a moving belt where washing and grading occur. At the washing plant an employee inspects the moving belt and removes any bones seen amongst the gravel. A total number of 429 identifiable animal remains, referable to 14 species, have been found by this means and by visual inspection of the pit itself during a period of five years up to the present time.

It was clear from the early stages of this investigation that a bewildering mixture of old and more recent relics was emerging from the pit. Some fossils such as mammoth teeth *(M. primigenius)* and woolly rhinoceros *(Coelodonta antiquitatis)* are indisputably Pleistocene, pertaining to the last (fourth) Glaciation, currently known to British palaeontologists as the Devensian, and corresponding to the Alpine IV Wurm Glaciation. Indeed *Coelodonta* is known to have become extinct well before the end of the Devensian, and vanished from the scene at least 36,000 years b.p. Other species found, such as reindeer *(Rangifer tarandus)* and aurochs *(Bos primigenius)* persisted from Pleistocene into Postglacial times. On the other hand considerable numbers of bones of domestic animals were also found, including cattle *(Bos taurus)*, pig *(Sus scrofa)*, sheep *(Ovis aries)*, and horse *(Equus caballus)*. The bones of these domestic animals were often recovered in the same 'batches' as the less numerous Pleistocene remains, giving rise to doubts regarding the chronological stratification of the gravels. It seemed very possible that as a result of river flood action there had been intrusion of older, fossil bones derived from other situations. The difficulty of resolving this problem, which cannot be considered altogether resolved even now, has been increased by the extreme

difficulty of manual excavation in this hard conglomerate gravel, composed of tightly packed flints of quite large average size. The fossil bones are clearly quite widely scattered throughout, although probably deposited in 'pockets' by river action.

Several pieces of evidence tend to suggest that the animal remains may in fact be stratified chronologically in spite of the confusion brought about by the mechanical methods of extraction described above. The first fossil, found by Dr. Jeffery Harrison in 1975 was an exceptionally fine intact adult *Mammuthus primigenius* molar (Plate IIA). It was found in the *bottom* of the pit, exposed after removal of the gravel layer. On the other hand a jaw bone of *Bos taurus* was found by D.L.H. embedded in the *top* of the gravel layer, after removal of the surface soil and before extraction of the gravel.

Recourse has been taken to modern scientific dating methods in a further effort to resolve this confusing situation. It was clear that the abundant remains of horse *(E. ferus caballus)* found included some highly mineralised fossil bones and others much lighter and more recent. Radiocarbon dating methods were employed to examine a horse metapodial found at the lowest level of the pit 2.4–3 m. deep. It gave a date of 7810 b.c. (9,760 b.p.) that is in the Post-glacial Mesolithic. Another lighter horse metapodial gave a radiocarbon date of 970 A.D. This investigation proves that the horse remains include the wild 'fossil horse' *Equus ferus* and its later domesticated descendant *E. caballus* (See discussion, p. 00). Pollen analysis of peaty material found in the internal cavities of some of the bones and presumed to be derived from decaying vegetation present at the site and period of the animals' death, has also assisted in dating the fossil material. Thus two aurochs *(Bos primigenius)* tibiae have given pollen datings corresponding to the Post-glacial period 9000–8000 years b.p. and 6500–5000 years b.p. respectively (*vide* Peglar, Appendix I) conforming both with the state of mineralization of the bones and the known history of the species (see Plate IIIA). Bronze Age axe-heads and remains of large and small domestic cattle, possibly associated with the Neolithic and Iron Age periods, have also been found. These finds contribute to the conclusion that the deposit provides evidence covering a long period of the wild and domestic mammal fauna of Sevenoaks. The history of the gravels extends from the mid-Devensian at least 36,000 years b.p. down to recent historical times, when the Darent Valley was clearly grazed by man's domestic herds just as it is today.

Whether or not the uncertainty of stratification can be finally resolved, this study tells us much about the past history of the site, thus adding a new dimension of interest to the Sevenoaks Reserve, already declared as an S.S.S.I. on account of its outstanding interest

to students of the present day fauna. The animal remains obtained are preserved in the Harrison Zoological Museum at Sevenoaks, forming a fascinating exhibit of the past history of the area.

List of measurements employed in the text (abbreviations and definitions)

AB	Antero-posterior diameter of antler burr
ARM	Median antero-posterior width of ascending ramus of mandible
BB	Breadth of cranium
CMB	Circumference of main beam of antler above brow tine
DHR	Depth of horizontal ramus of mandible behind last molar
DHRP	Depth of horizontal ramus of mandible in front of pm_1
GAPDR	Greatest antero-posterior diameter of proximal extremity of radius
GDLT	Greatest diagonal length of tooth
GH	Greatest height
GHT	Greatest height of tooth
GL	Greatest length
GLC	Greatest length of crown
GLLC	Greatest length of lower carnassial
GWC	Greatest width of crown
GLm_3	Greatest length of third lower molar
HLC	Height of lower canine, from cingulum to tip
MB	Antero-posterior diameter of main beam of antler above brow tine
MSD	Mid-shaft depth
MSW	Mid-shaft width
TFW	Transfrontal width anterior to supraorbital foramen
WDE	Width of distal extremity
WI	Width of interparietal across anterior extension
WPE	Width of proximal extremity

Systemic List

Fam. Hominidae
Homo sapiens Man
Material: HZM 1.10564 Femoral shaft. This was the femoral shaft of a female or immature *H. sapiens.*
Remarks: The age of this specimen is of considerable interest, but as discussed in a later section, it could not be sacrificed for radio-carbon dating, and relative dating (by estimation of nitrogen, fluorine and uranium) was inconclusive, although tending to show that the bone was not recent. Other evidence from the site (antler mace head, Plate IIIB and bronze axes) testifies to man's presence in the Darent Valley, probably continuously, since at least Neolithic times.
Measurements (mm.): Femoral shaft (HZM 1.10564) MSW 24.9 MSD 23.8.

Fam. Canidae
Canis familiaris Domestic Dog
Material: HZM 11.8538 pm^4, m^1 and m^2
HZM 12.9234 Scapula
HZM 13.9463 Tibia
HZM 14.9688 Humerus
HZM 15.9764 Intact skull and mandible
HZM 16.9765 Femur
HZM 17.10096 Mandible
HZM 18.10097 Tibia
HZM 20.10293 Mandible
HZM 21.10294 Femur

Remarks: The Canid material from our deposit is all referable to the domestic dog, *C. familiaris*. The well-preserved skull and mandible 15.9764 is of special interest being mineralised and clearly of considerable age. Like the domestic cat, these remains most likely date from early historical times, although the earliest domestic dog yet found in British deposits, from Star Carr was dated at 7500 B.C.[3] Both small and large domestic dogs are represented in this sample.

Fam. Felidae
Felis catus Domestic cat
Material: HZM 5.9461 Mandible
Remarks: This single specimen of domestic cat, distinguishable from wild cat by the small size of the jaw and dentition, clearly represents one of the more recent faunal components of the deposit, deriving from the historical period.
Measurements (mm.): Mandible (HZM 5.9461) GL 59.0 GLLC 8.1 HLC 8.8

Fam. Elephantidae
Mammuthus primigenius Woolly mammoth
Material: HZM 1.8360 Intact adult cheektooth (Plate IIA)
HZM 2.9228 Unerupted deciduous cheek tooth
HZM 3.9313 Part adult cheektooth
HZM 4.9342 Part adult cheektooth
HZM 5.9343 Part adult cheektooth
HZM 6.9344 Part adult cheektooth
HZM 7.9345 Part adult cheektooth
HZM 8.9346 Part adult cheektooth

[3] M. Degerbol, 'On a Find of a Preboreal domestic Dog (*Canis familiaris* L.) from Star Carr, Yorkshire, with Remarks on other Mesolithic dogs', *PPS*, xxvii (1961), 35–55.

Remarks: It is interesting that no skeletal remains of mammoth have been recovered at this site, molar teeth alone providing evidence of the presence of this typical Devensian (last glaciation) mammal. The intact adult molar has roots present and the tooth was clearly unrolled.
Measurements (mm.): Ad. cheektooth (HZM 1.8360) GLC 198 GWC 108 GDLT 312 GHT 232

Fam. Rhinocerotidae
Coelodonta antiquitatis Woolly rhinoceros
Material: HZM 1.9602 Tibial shaft
HZM 2.10528 Femoral shaft (Plate IIB)
Remarks: These finds are the only specimens from the site referable to the species and are outstandingly different from all other tibiae and femora found in the deposit on account of their short broad 'graviportal' aspect (see Plate IIB). Material from the medullary cavity of HZM 1.9602 was examined for pollen content, but proved to have no associated pollen. It is, however, certain that these bones cannot be later than mid-Devensian *c.* 36,000 yr. b.p.[4] The broad flattened femur with greatly developed third trochanter is especially characteristic of rhinoceros.
Measurements (mm.): Tibia (HZM 1.9602) MSW 63.8 MSD 57.1
Femur (HZM 2.10528) MSW 86.9* MSD 60.1 *Below third trochanter

Fam. Equidae
Equus ferus Wild horse
Equus caballus Domestic horse
Material: The material from the site comprises twenty-seven cranial and eighty-nine postcranial specimens.
Measurements: These are available in the archives of the Harrison Zoological Museum.
Remarks: Remains of horse are one of the most abundant species in the gravels. Many of the specimens are highly mineralised and clearly of great age. Others are lighter and appear more recent. Radiocarbon dating of two metapodials selected on this basis has given confirmation of this impression. HZM 15.9217 (a light bone) gave a carbon date of *c.* 970 A.D. (Saxon), while HZM 8.8535 (a heavy bone) proved to be *c.* 7,810 b.c. (*c.* 9760 b.p.) (Plate IVB). The latter Post-glacial Mesolithic date is of particular interest as it is the most recent date so far obtained for the wild horse, *Equus ferus,* in Britain. (See discussion). There appears to be no certain way of

[4] A.J. Stuart, 'Pleistocene History of the British Vertebrate Fauna', *Biol. Rev.*, xlix (1974), 225–66.

distinguishing the remains of *E. ferus* from its domestic descendants *(E. caballus)* in our deposit, apart from the generally heavier more mineralised state of the bones. They are accordingly treated here together.

Fam. Suidae
Sus scrofa Pig/Wild boar
Material: The material from the site comprises five cranial and seven postcranial specimens.
Remarks: The distinction of wild from domestic pig is not always easy. Clason (1967)[5] has shown that the size of the posterior cheekteeth, both upper and lower, will distinguish wild boar from domestic hog by average size difference in any particular region. There is good reason to believe that our limited material contains both. Thus the mandible of a young pig, with m_3 not fully erupted (HZM 7.9887) has small canine tusks and small cheekteeth and must surely have been domestic. On the other hand HZM 12.10009 (anterior mandibles) and 14.10498 (horizontal ramus with GLm_3 34.6 mm.) both have much larger cheekteeth and are much more mineralised and could have been the wild boar. A massive posterior mandible HZM 13.10495 equals in size and considerably exceeds in thickness the mandible of an adult male recent Wild Boar from Holland (HZM 2.6143; 1.5660 Onzalige Boosen, nr. Arnhem). This and the large axis vertebra (HZM 10.9933) appear to us convincing evidence of Wild Boar in the deposit. The age of these specimens is uncertain, as the species may well have existed in the area throughout the history of the deposit.

Fam. Cervidae
Rangifer tarandus Reindeer
Material:

HZM	3.8536	Part antler
HZM	4.8537	Part antler
HZM	11.10448	Part antler (Plate VA)
HZM	12.10462	Part antler (Burr and brow tine)

Measurements (mm.): *Antlers* HZM 11.10448 AB 43.3 MB 43.3 CMB 119HZM 3.8536 AB 44.1 MB 44.3 CMB 124
Remarks: These highly characteristic antler specimens, two of which include the burr, part of the flattened main beam and massive brown tine, are the only evidence recovered of *Rangifer* in this deposit. They are readily distinguishable from the more abundant antler fragments of *Cervus* and *Dama* present in the gravels. These

[5] A.T. Clason, 'Animal and Man in Holland's Past', *Palaeohistoria*, (1967), 13A, 61–3.

antlers were clearly derived from large reindeer. They are one of the older faunal elements in the deposit. (See discussion).

Capreolus capreolus Roe deer
Material: HZM 10.10258 Part metapodial
HZM 11.10494 Part antler and frontal (Plate VC)
Remarks: The presence of roe deer in this deposit is attested by only one part of antler and one broken metapodial, which are, however, quite characteristic. Both were recovered in August–December 1979 from the deep hole to the north of the East Lake (Site 2). This species is thus the least abundant Cervid in the gravels. Although roe deer existed in Britain in the Pleistocene, these early representatives were larger than the modern species (Kurten, 1968)[6] and it seems more likely that these specimens belong to the more recent fauna of the gravels.
Measurements (mm.): *Metapodial* HZM 10.10258 MSW 13.1 MSD 17.9 *Antler* HZM 11.10494 AB 34.0

Dama dama Fallow deer
Material: This comprises one radius, one mandible, four cranial fragments with basal antlers attached, one cranial fragment and ten part antlers.
Remarks: The seventeen identifiable specimens of fallow deer from the gravels form a characteristic assemblage readily identifiable by their size from the larger remains of *Cervus* and *Rangifer* in the deposit. Several of the antlers show evidence of the characteristic palmation. Some selected measurements of the adult specimens are given below (Table I) in comparison with modern park fallow deer from Knole Park, Sevenoaks. Allowing for the considerable individual, sexual and age variations present in deer, it is clear that the material from the Darent river gravels corresponds quite closely with the recent park fallow deer in size, and represents a re-introduced population in historical times. The indigenous fallow deer, which became extinct in the upper Pleistocene, was evidently larger than the modern form.[6] The Post-glacial history of the species in Britain is, however, obscure and precise dating of the material from the Darent gravels is therefore of special interest. (See p. 00).

Cervus elaphus Red deer
Material: The material comprises eleven cranial, twenty-four antler and twenty-five postcranial specimens.

[6] B. Kurtén, *Pleistocene Mammals of Europe,* World Naturalist, London, 1968, 1–317.

TABLE I *Dama dama* (Measurements: mm.)

Darent River Gravels		DHR	BB	ARM	WI	AB	TFW	MSW	MSD	WDE
Cranium	HZM 4.9768		79.4		39.8					
Mandible	HZM 8.9798	32.6		27.3						
Cranium + Antler	HZM 3.9767					44.1	46.8			
Cranium + Antler	HZM 2.9766				CMB 84	47.8				
Antler	HZM 17.10015					48.7				
Antler	HZM 16.10014					46.9				
Antler	HZM 19.10094					47.7				
Antler	HZM 20.10095					41.0				
Antler	HZM 7.9771					50.7				
Antler	HZM 5.8769					41.8				
Radius	HZM 15.9921							23.2	13.3	39.4
Knole Park, Sevenoaks, (Recent)					WI					
Cranium	HZM 9.9915	37.4	78.1	31.9	36.1	52.8	48.9			
Radius	HZM 21.10135							22.3	13.0	41.8

Measurements: These are available in the archives of the Harrison Zoological Museum.
Remarks: The red deer is the most abundant Cervid in the deposit. It is probably one of the species present throughout the entire history of the gravels, from the Devensian to recent historical times. Although it is yet unconfirmed by precise dating methods, the massive size of some specimens (e.g. antler HZM 38.10311, Plate VB) provides evidence of the presence of the large 'Cold Phase' red deer present in southern Britain in Devensian and Post-glacial times. This species no longer exists in the Sevenoaks area.

Fam. Bovidae
Bos primigenius Aurochs
Material:

HZM	2.8701	Tibial shaft
HZM	4.9230	Tibial shaft and associated fragment (Plate IIIA)
HZM	3.9229	Distal tibia
HZM	12.9603	Distal tibia
HZM	6.9579	Distal tibia
HZM	14.9681	Distal humerus
HZM	9.9582	Proximal radius
HZM	11.9584	Proximal horn core fragment
HZM	7.9580	Proximal horn core fragment
HZM	8.9581	Horn core fragment
HZM	15.10091	Metacarpal (intact) (Plate IVA)
HZM	13.9680	Proximal metapodial
HZM	10.9583	Proximal metapodial
HZM	1.8541	Proximal metapodial
HZM	17.10257	Horizontal ramus mandible
HZM	18.10492	Neural spine of vertebra
HZM	19.10493	Rib
HZM	20.10496	Part proximal radius

Remarks: Remains of the aurochs are readily distinguishable by their massive size and more mineralised condition from the much more recent domestic cattle *(Bos taurus)* in the deposit. Distinction from the Pleistocene steppe wisent *(Bison priscus)* is more difficult and the presence of this Devensian species in the deposit cannot be excluded. However, successful pollen analysis of material from the medullary cavities of two tibiae (see Appendix I) has given the following results: HZM 4.9230 Pollen Zone VII or 7000–5000 years b.p.; HZM 3.9229 Pollen Zone VI 9–8000 years b.p. These Post-glacial datings confirm the identification of these specimens as *B. primigenius* and the material at present available is all considered provisionally as aurochs pending confirmation of the presence of

TABLE II *Bos primigenius* (Measurements: mm.)

		MSW	MSD	WDE	GL	WPE	DHRP	GAPDR
Tibial Shaft	HZM 2.8701	62.9	54.8					
Tibial Shaft	HZM 4.9230	57.5	43.7	77.8				
Distal Tibia	HZM 3.9229			78.4				
Distal Tibia	HZM 12.9603			76.2				
Distal Tibia (eroded)	HZM 6.9579			76.0				
Distal Humerus	HZM 14.9681			97.3				
Metapodial (anterior)	HZM 15.10091	43.8	32.2	77.1	257	76.6		
Metapodial (anterior)	HZM 13.9680	46.6	34.8			78.8		
Metapodial (posterior)	HZM 10.9583					60.4		
Horizontal Ramus Mandible*	HZM 17.10257						48.1	
Proximal Radius	HZM 20.10496							58.4

* Root sockets of mandibular teeth suggest this was a young aurochs. Nevertheless this mandible is outstandingly larger than the many *Bos taurus* mandibles recovered from this deposit.

steppe wisent. Some measurements of this material are given in Table II.

Bos taurus Domestic ox
Material: This comprises twenty-four cranial and one hundred and twenty-two postcranial specimens.
Remarks: Remains of domestic cattle form one of the most abundant components of this collection. They are generally easy to distinguish from *Bos primigenius* by their much smaller size. Measurements of some metacarpal specimens are given below (Table III) for comparison with the remains of aurochs recovered.

HZM 70.9946 (Frontal bone and bone core) is of particular interest on account of its remarkably small size. This specimen came from a domestic cow so small it can scarcely have been larger than a modern sheep. This minute type of domestic ox was characteristic of the Iron Age. The horn core measures a mere 52.7 mm. long by 28.5 mm. basal width. The series of intact metacarpals are also of some interest. The largest of the series referred to *Bos taurus* is HZM 92.10032 which surprisingly came from a young animal since the distal epiphysis is not fused. It is nevertheless considerably smaller than *Bos primigenius* and could represent the large early domestic cattle of Neolithic and Roman times. Radii 132.10534 and 133.10535 are perfect pairs and the former articulates perfectly with humerus 114.10499 and is compatible with part metacarpal 126.10517 all found at the same time. Probably all part of a small Iron Age cow.

TABLE III *Bos taurus* (Measurements: mm.)

		MSW	MSD	WDE	GL	WPE
Metacarpals	HZM 115.10500	30.2	21.8	54.5	202.0	52.2
	HZM 92.10032	31.7	23.8	64.2	225.0	61.0
	HZM 96.10092	34.4	23.7	58.9	202.8	58.1
	HZM 100.10238	27.9	22.3	52.6	201.3	50.5
	HZM 8.9219	33.6	24.9	61.3	195.2	59.7
	HZM 111.10489					48.7

Ovis aries Domestic sheep
Material: This comprises one cranial and sixteen postcranial specimens.
Measurements: These are available in the archives of the Harrison Zoological Museum.
Remarks: Remains of domestic sheep are considerably less abundant than those of domestic cattle and horse in the deposit. They clearly represent one of the more recent faunal components of the gravels.

DISCUSSION

Chronology of the faunal remains from the Darent gravels

By Richard Burleigh

It is well known that in the laying down of fluviatile deposits fossil remains of widely different age can become incorporated and intermixed. Evidently, the animal remains found in the Darent river gravels are no exception to this as the list includes species belonging to the extinct Pleistocene fauna, such as mammoth, as well as the bones of recent domestic animals. Apart from remains such as these which fell into distinct categories, the dating of some others that were recovered, notably those of horse (*Equus* sp.), reindeer *(Rangifer tarandus)* and fallow deer *(Dama dama)*, was less certain. To help resolve this four bones of horse and two fragmentary antlers, one of reindeer and one of fallow deer, were selected for radiocarbon dating. These specimens were chosen for their particular relevance to a joint programme of research, by the Department of Zoology of the British Museum (Natural History) and the Research Laboratory of the British Museum, into the latest dates of survival of larger terrestrial mammals in Britain following the end of the last (Devensian) glaciation. Collagen (the remnant of the original protein) was recovered from the samples of bone and antler by demineralization with dilute acid and converted quantitatively to benzene for measurement of C^{14} activity by the liquid scintillation counting method. The radiocarbon ages obtained from these measurements are given in Table IV. From these results it will be seen that although three of the equid bones and the antler of fallow deer are of roughly medieval to modern date, one equid metapodial (HZM 8.8535, BM–1619) and the antler of reindeer (HZM 12.10462, BM–1674) are approximately 10,000 radiocarbon years old.

These two results are of the greatest interest, both from the point of view of the present investigation and that of post-Pleistocene mammalian survivals in Britain. There are few other late records for

PLATE IIA

(Photo. D.L. Harrison)

Mammuthus primigenius
Intact adult Molar (HZM 1.8360). Scale = 5 cm.

PLATE IIB

(Photo. D.L. Harrison)

Coelodonta antiquitatis
Femur Shaft (HZM 2.10528). Scale = cm. and mm.

PLATE IIIA

(Photo. D.L. Harrison)

Bos primigenius
Tibial Shaft and associated proximal Fragment (HZM 4.9230). Pollen dating Zone VIIa 7000–5000 r.c. years b.p. Scale = 8 cm.

PLATE IIIB

(Photo. D.L. Harrison)

Cervus elaphus
Basal Antler (HZM 52.10497) converted into Axe by Stone Age Man. Scale = 3 cm.

PLATE IVA

(Photo. D.L. Harrison)

Left: *Bos taurus* (HZM 96.10092)
Right: *Bos primigenius* (HZM 15.10091)
Metacarpal Bones. Scale = cm. and mm.

PLATE IVB

(Photo. British Museum)

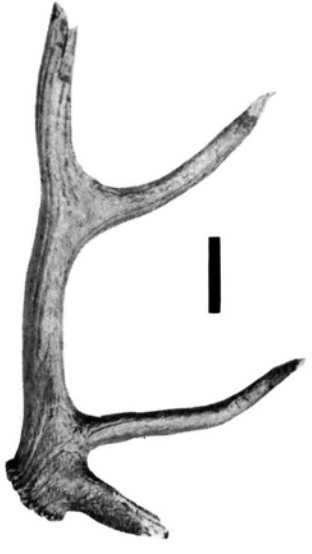
Metapodials of Caballine Horse from the Darent River Gravels
Left: Wild Horse *(Equus ferus)* HZM 8.8535 Radiocarbon Date *c.* 9770 b.p.(Post-glacial Mesolithic)
Right: Domestic Horse *(Equus caballus)* HZM 15.9217 Radiocarbon Date *c.* 980 b.p. (Saxon)

PLATE VA

(Photo. D.L. Harrison)

Rangifer tarandus
Antler (HZM 11.10448) Scale = 4 cm.

PLATE VB



(Photo. D.L. Harrison)

Cervus elaphus
Antler (HZM 38.10311) Scale = 76 mm.

PLATE VC

(Photo. D.L. Harrison)

Antlers:
Above: *Dama dama* (HZM 20.10095)
Below: *Capreolus capreolus*
(HZM 11.10494) Scale = 5 cm.

reindeer (cf. dates for reindeer remains associated with a Creswellian industry from Anston Stones Cave, Yorkshire: 9850 ± 115, 9940 ± 115 and 9750 ± 110 b.p., BM–439, 440a and 440b respectively),[7] and no other records at all for horse until it was reintroduced as a domestic animal in the late Neolithic or early Bronze age.

The question of the age of the human femoral shaft (HZM 1.10564) was naturally of considerable interest. Unfortunately, the application of conventional radiocarbon dating to this specimen would have necessitated destroying it entirely. Non-destructive radiocarbon dating of finds such as this should eventually be possible by means of the accelerator and small-counter methods now being developed. These new methods of radiocarbon measurement will consume samples of only a few milligrams of carbon, or about one-thousandth of the minimum amount needed at present. In the meantime, assessment of the probable age of imperfectly stratified, but potentially important finds of this sort is almost entirely dependent on chemical methods of relative dating, in particular the estimation of nitrogen, fluorine, phosphorus and uranium.[8] For this purpose a small sample of bone was removed from the femoral shaft without causing serious damage to the specimen as a whole, and the nitrogen, fluorine and phosphorus content of this sample was determined by neutron activation analysis. The natural uranium content of the sample was determined separately by gamma spectrometry.[9] In Table V the results are compared with the corresponding analyses for a sample of the reindeer antler (HZM 12.10462), dated by radiocarbon to 9760 ± 70 b.p. (BM–1674, Table IV).

Relative dating based on comparison of the nitrogen, fluorine and uranium contents of fossil bone and antler depends on the tendency for nitrogen (representing the original protein) to decrease with the lapse of time, whilst fluorine and uranium (from percolating groundwater) tend to increase (up to certain theoretical maximum values).

On the basis of the nitrogen and fluorine content of the sample of human bone compared with that of the reindeer antler, the human bone appears to be of at least comparable age, but its much lower

[7] *Radiocarbon,* xiii (1971), 167.

[8] K.P. Oakley, 'Relative Dating of the Fossil Hominids of Europe', *Bull Br. Mus. Nat. Hist.,* (Geol.) xxxiv (1980), 1–63.

[9] I.C. Demetsopoullos, R. Burleigh, and K.P. Oakley, 'Relative and absolute Dating of the human Skull and Skeleton from Galley Hill, Kent' *(in press).*

uranium content does not support this conclusion (although uranium in bone sometimes varies erratically). The nitrogen and fluorine content may indicate that this bone is ancient, and certainly it is not very recent for modern bone contains about five per cent of nitrogen and negligible fluorine, but it cannot be more decisively dated than this from these data alone. This particular individual cannot therefore be assigned a definite place in any given segment of the fauna from the gravels; he or she is as likely to have been a medieval peasant as a prehistoric hunter-gatherer or farmer.

Further evidence relating to the chronology of faunal remains from the gravels has been provided by pollen analysis of sediment from within two tibiae of aurochs *(Bos primigenius)*, as described by Dr. Sylvia Peglar in Appendix I. Dr. Peglar's results suggest minimum ages in the range of 9000–8000 b.p. and 7000–5000 b.p., respectively, for these two bones (HZM 3.9229 and HZM 4.9230), and are consistent with other fossil and dating evidence for the occurrence of *Bos primigenius* in Britain from at least the earlier part of the Post-glacial (Flandrian), through the Neolithic period and eventual latest survival into the Early Bronze Age.[10]

Lastly, the perforated basal part of a red deer antler (HZM 52.10497, Plate IIIB) was a find that could be reasonably closely dated archaeologically. It belongs to the interesting and uncommon group of artifacts known as antler mace-heads, several other examples of which have been found in the Thames Valley.[11,12] Antler mace-heads of this general type are represented in the collections of the Department of Prehistoric and Romano-British Antiquities, British Museum, by both provenanced and unprovenanced examples. The former include an early barrow find of laterally perforated form from Stancomb, Lambourn, Berkshire (Reg. no. 79, 12–9, 1797) and an example (Reg. no. 79, 12–9, 551) perforated in a similar manner to that from the Darent gravels, but showing numerous saw-marks, from Cowlam Barrow (BB57), Humberside, a context suggestive of a fairly late Neolithic burial.[13] An unprovenanced specimen (Reg. no. 1906, 7–2, 3) in the collection is also very similar in appearance to the Darent find. Other

[10] R. Burleigh and J. Clutton-Brock, 'A radiocarbon Date for *Bos primigenius* from Charterhouse Warren Farm, Mendip', *Proc. Univ. Bristol Speleol. Soc.* xiv (1977), 225–7.

[11] R.A. Smith, 'Specimens from the Layton Collection, in Brentford Public Library', *Archaeologia*, lxix (1918), 1–30.

[12] G.F. Lawrence, 'Antiquities from the Middle Thames', *Arch. Journ.*, lxxxvi (1929), 69–78.

[13] I. Kinnes, *Round Barrows and Ring-ditches in the British Neolithic* (British Museum Occasional Paper No. 7). London, 1979, 17 (Dc5), 65, Figs. 3.2, 3.3.

examples have been recorded elsewhere in Britain in association with middle and later Neolithic wares.[13,14] Although Jessup[15] has figured one of these antler mace-heads from the Thames alongside Mesolithic (Maglemose) artifacts, they very clearly belong to the Neolithic period; Mesolithic examples (mattock-heads) tend to have more regular perforations of smaller diameter and were made from the (distal) epiphyses of aurochs' radii rather than antler. Antler mace-heads appear to have been in use from the middle to late Neolithic, *c.* 2400–1800 b.c. and the Darent example almost certainly belongs within this period.

TABLE IV *Radiocarbon dates for selected animal remains from Darent river gravels*

Material	HZM reg.	Radiocarbon age rel. A.D. 1950 (5570 yr half-life)	Lab. No.
Equus metapodial	15.9217	980 ± 75 b.p. (a.d. 970)	BM–1618
Equus metapodial	8.8535	9770 ± 80 b.p. (7820 b.c.)	BM–1619
Equus metapodial	92.10007	115 ± 35 b.p. (a.d. 1835)	BM–1672
Equus metapodial	Unreg.	780 ± 60 b.p. (a.d. 1170)	BM–1673
Rangifer tarandus antler fragment	12.10462	9760 ± 70 b.p. (7810 b.c.)	BM–1674
Dama dama antler fragment	2.9766	145 ± 60 b.p. (a.d. 1805)	BM–1675

TABLE V *Elemental analyses of samples of bone from human femoral shaft and reindeer antler dated independently by radiocarbon* (for convenience measured values have been rounded in the table; normalized 100F/P205 figures rather than per cent F should be compared)

Material	Wt (g)	HZM reg.	Age b.p.	N %	F %	P %	100F/ P205	U ppm *e.*U_3O_8
H. sapiens femoral shaft	0.7	1.10564	–	1.1	1.0	12.4	3.3	<3.0
R. tarandus antler	0.9	12.10462	9760 ± 70 (BM–1674)	2.2	0.7	14.4	2.0	12.0

[14] S. Piggott, *Neolithic Cultures of the British Isles*, (reprinted 1970), Cambridge, 333, 355–62 *passim.*

[15] R. Jessup, *South-East England,* London, 1970, 63, Pl. 10.

Worked flint

A single worked flint was found in April 1981 by Guy Harrison on the surface of the diggings. This flake of dark flint, measuring 50 × 24 mm., had evidently been struck from a core and had a well-marked platform and bulb, and some evidence of rebacking on one edge and possible signs of use on the other edge. The flake is probably Mesolithic or Neolithic rather than Palaeolithic in date.

APPENDIX I

Pollen analyses of sediment from two examples of Bos primigenius bones recovered from the Darent river gravels at Sevenoaks, Kent

by SYLVIA PEGLAR

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Sediment from within two aurochs' tibiae found in the Darent river gravels, was submitted for pollen analysis.

The material was prepared by heating with 10% hydrochloric acid to remove carbonates, sieving through a 180μm mesh sieve to remove large organic and inorganic particles, boiling with 10% sodium hydroxide to remove humic acids, boiling with 60% hydrofluoric acid to remove silicates, and boiling with 9 parts acetic anhydride to 1 part concentrated sulphuric acid to hydrolyse cellulose.[16] The remaining material was then stained with safranin to facilitate the identification of pollen and spores, and mounted in 2000 cs. silicone oil.

250–300 identifiable grains and spores were counted from each sample at a magnification of 400x.

The pollen and spore assemblage from Tibia A (HZM 3.9229) has a high *Corylus* pollen percentage, significant *Pinus, Ulmus* and *Quercus* values, and almost no *Alnus* pollen, and no *Tilia* pollen at all. Such an assemblage closely correlates with Godwin's early to middle Flandrian (post-glacial) zone VI[17,18] dated from approxi-

[16] H.J.B. Birks and H.H. Birks, *Quaternary Palaeoecology,* London, 1980, 157.
[17] H. Godwin, 'Pollen Analysis and Forest History of England and Wales', *The New Phytologist,* xxxix (1940), 370–400.
[18] H. Godwin, *History of the British Flora,* 2nd ed., London, 1975.

The results are given below:–

	Tibia A (HZM 3.9229)		Tibia B (HZM 4.9230)	
	Number	% total land grains & spores	Number	% total land grains & spores
Trees:				
Betula	4	1.6	3	1.1
Pinus	7	2.8	1	0.4
Ulmus	8	3.2	3	1.1
Quercus	21	8.4	16	5.9
Tilia cordata	–		19	7.0
Alnus	1	0.4	159	58.9
Shrubs:				
Corylus	169	67.6	32	11.9
Salix	2	0.8	–	
Hedera	–		2	0.7
Herbs:	Grains or Spores		Grains or Spores	
Gramineae	3	1.2	14	5.2
Cyperaceae	15	6.0	8	3.0
Tubuliflorae	6	2.4	1	0.4
Rosaceae	–		1	0.4
Filipendula	1	0.4	–	
Rumex acetosa-type	1	0.4	2	0.7
Urtica	–		1	0.4
Ferns:				
Polypodiaceae undiff.	10	4.0	5	1.9
Polypodium	–		3	1.1
Total:	250		270	
Aquatic:				
Sparganium-type	1		–	
Moss:				
Sphagnum	2		–	
Indeterminable pollen	66		44	

mately 8000–9000 years b.p. (6000–7000 years b.c.). The pollen assemblage suggests widespread hazel scrub with some areas of mixed deciduous woodland.

The assemblage from Tibia B (HZM 4.9230) with high *Alnus* and *Tilia* pollen values, and comparatively low *Pinus, Betula* and *Corylus* pollen frequencies is indicative of a Flandrian pollen zone VII age.[17] The vegetation was probably mixed deciduous forest with abundant alder in wet areas. The high value of *Alnus* pollen which depresses the other pollen values includes many clumps of alder

pollen grains in the preparation. These clumps indicate that *Alnus* grew close to the site of deposition. The small percentage of herb pollen and the absence of any *Plantago lanceolata* pollen, together with a relatively high amount of *Ulmus* pollen, suggest that the pollen assemblage correlates with subzone VIIa that dates from 5000–7000 years b.p. (3000–5000 years b.c.).

These pollen assemblages are similar to those from the Isle of Grain and the New Dartford Tunnel site nearby which are assigned to zones VI and VIIa.[19]

It must be remembered firstly that these sediment samples are from bones which have probably been washed into the Darent river gravels from their place of primary deposition; and secondly, that sediment may not have been accumulated inside the bones until some time after death and decomposition. Thus the suggested datings from the analyses can only give us the latest dates at which the animals perished – they may have died some time before.

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[19] R.J.N. Devoy, 'Flandrian Sea Level Changes and vegetational History of the lower Thames Estuary', *Philosophical Transactions of the Royal Society London, 1979, B., 285,* 355–410.