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An Early Upper Palaeolithic Open-air Station and Mid-Devensian Hyaena Den at Grange Farm, Glaston, Rutland, UK

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Archaeological work preceding a housing development revealed mid-Devensian (MIS 3) deposits preserved in a geological fault, a graben feature, on an interfluve plateau. Rare evidence for Early Upper Palaeolithic open-air occupation was characterised by a scant lithic signature of the Lincombian-Ranisian-Jerzmanowician (LRJ) leaf-point techno-complex of the North European plain. The lithics included a complete leaf-point, another broken example with traces of impact damage, and knapping debitage indicating leaf-point maintenance. The site also preserved good evidence for an open-air hyaena den with abundant faunal remains. Discrete bone clusters were present, some of which probably represent meat caches for hyaena cubs in the burrows and scrapes of a maternity den. It is suggested that the hominins targeted the den site to forage the stored food. Their occupation is associated with a group of spirally-fractured wild horse bones thought to be the result of marrow extraction by humans, and these have been dated to 44,290–42,440 calibrated years before present (44.3–42.5 kyr cal BP*), comparable to the date range of continental LRJ sites. The early date of the LRJ techno-complex corresponds with that of the oldest Neanderthals in northern Europe, but possibly overlaps with the recently reported early dates for anatomically modern humans. However, it is concluded that the oldest Early Upper Palaeolithic technology in northern Europe was the product of final Neanderthals.*

Over the course of several months in 2000 a team from University of Leicester Archaeological Services (ULAS) excavated rare evidence of an Early Upper Palaeolithic open-air site juxtaposed with the remains of a hyaena den. The site is located within the small village of Glaston, 9 km south-east of Oakham, Rutland (Figs 1 & 2). The Pleistocene remains were a chance, unanticipated discovery during the final week of a routine excavation of medieval village core remains in response to redevelopment proposals. Sand quarrying in the 1940s had revealed Bronze Age and Anglo-Saxon burials in fields adjacent to the site indicating there was high potential for further remains in the development area (Powell 1950; Leeds & Barber 1950). In the event no more burials were found, but a sequence of medieval and post-medieval village remains was recorded (Cooper & Thomas 2001). Towards the end of this initial excavation an assemblage of animal bone and a retouched flint blade were recovered from what had previously been assumed to be undisturbed 'natural' sands. The blade was identified as an Early Upper Palaeolithic leaf-point, whereas the bones (woolly rhinoceros: *Coelodonta antiquitatis*, wild horse: *Equus ferus*, and wolverine: *Gulo gulo*) suggested it was a contem-

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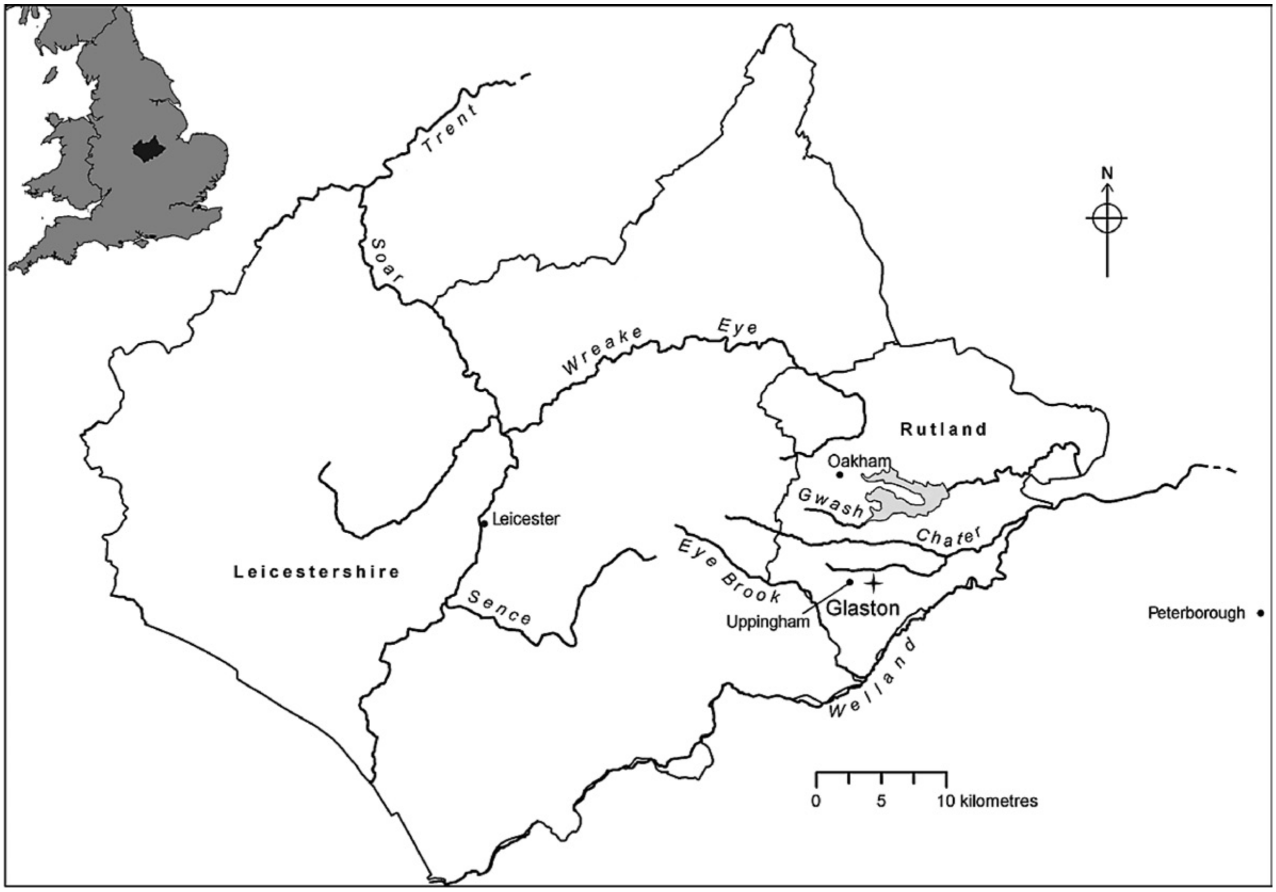

Fig. 1.
Location plan

porary mid-Devensian deposit of Marine Isotope Stage 3.

English Heritage provided funding for an evaluation and subsequent excavation of the Pleistocene deposits. The ULAS team was augmented with direct involvement of staff from English Heritage, the British Museum, the Natural History Museum, and Oxford Archaeological Associates. The aims and objectives of the excavation and post-excavation analysis (Cooper *et al*. 2003) included:

- An understanding of the site formation in terms of geological, zoogenic and anthropogenic transforms
- Establishing a site chronology.
- Understanding the *chaîne opèratoire* of the lithic assemblage.
- An understanding of the contemporary environment and climate.
- Establishing the ecological relationships of the animals, especially that between the co-existing top predators of human and hyaena.
- Reviewing the broader scene issues in the archaeology of the period.

METHODS

The extent of Pleistocene deposits was assessed by an evaluation involving a few test pits and observations in the sides of later negative features. Any remaining later archaeological deposits were systematically removed across the entire area thereby exposing the underlying

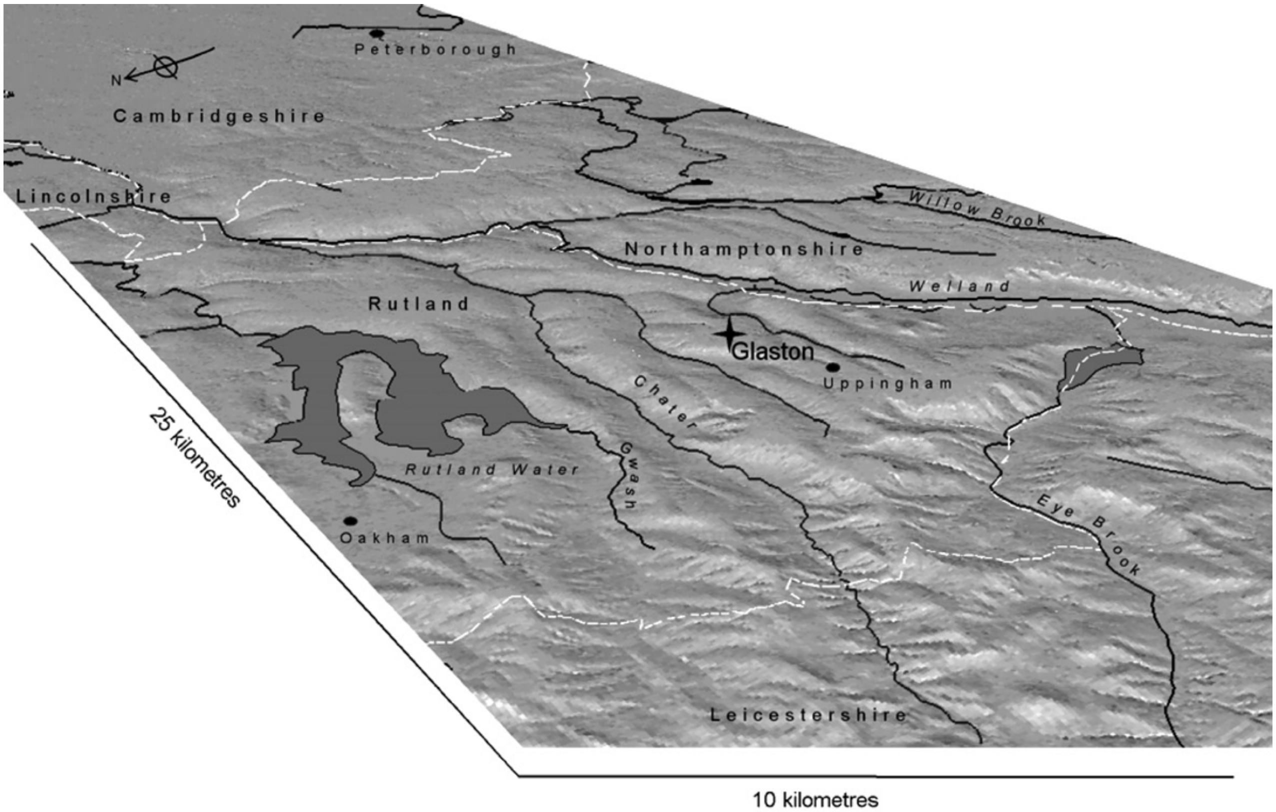

Fig. 2.
Hillshade plot facing east generated from elevation data. The vertical axis has been increased by a factor of five to enhance the topographic changes. © Crown Copyright/database right 2009. An Ordnance Survey/Edina supplied service

Pleistocene and Jurassic sands. The Jurassic deposits, the undisturbed 'natural', could be identified in section as laminated sand. The reworked deposits were identified as faulted blocks of laminated sand with evident slippage planes or, more usually, reworked sands with loss of laminations. Two areas of the site were chosen for further investigation (Figs 3 & 4). Area A, on the northern side of the site, contained the location of the original bone and flint discovery and was regarded as having the highest potential for the survival of Palaeolithic remains. This was subject to full excavation. Area B was judged to have slightly lower potential and a small sample area with well-preserved animal bone was subject to further excavation.

Conventional stratigraphic excavation was precluded by the convoluted nature of the Pleistocene sands, so an alternative strategy was implemented. A grid was laid out across the excavation area, effectively dividing the site into a series of 1 m^2 boxes. Each box was excavated in 50 mm deep spits then cleaned, planned, and photographed following each spit removal. Excavation ceased when undisturbed Jurassic sands were reached. Alternate boxes were excavated in the first instance to create a 'chequer board' pattern and to reveal continuous running sections across the site. All finds were located three-dimensionally and larger finds were drawn and photographed *in situ*. Each find was allocated an individual identifying code and entered onto the site database. Routine magnetic susceptibility readings were taken at each spit level to check for episodes of burning but none was found. A 25% sample of each spit was wet-sieved to 0.5 mm for micro-faunal remains and flint micro-debitage. This sample was

Fig. 3.
The site viewed from the south, showing the excavation areas beneath the polytunnels

increased if abundant small finds were visible to the naked eye or if a sample from a previous spit had yielded significant amounts. While the planum method of excavation was the norm it was occasionally possible to identify the base of hyaena burrows where they cut into undisturbed Jurassic sands: these were emptied stratigraphically.

GEOMORPHOLOGY AND TAPHONOMY

Glaston is on a high east–west ridge top, which has potentially been an important route of communication for millennia and currently holds the main A47 road. The ridge is flanked to the south by a tributary of the River Welland, and to the north by a tributary of the River Chater. Although the remains of the 1940s sand quarry obscure some of the detail, the general ridge top morphology comprises slightly raised southern and northern rims flanking an intervening broad and relatively flat depressed area. The site itself lies towards the 'inner' slope of the northern rim, at a height of *c.* 122 m above OD. The preservation of the site appears to have been due to a micrograben system, what has been termed the 'Sackung process' whereby the crest of the ridge subsided into a fault basin caused by cambering of the valley sides (Collcutt 2001; 2006).

The basement Jurassic geology of the site and its environs is mapped conventionally as Grantham Formation sands with a capping of Collyweston Facies lying continuously across the hilltop. The British Geological Survey mapping also includes notional normal faults, with downthrow towards the valleys, on both flanks of the hill. However, the disposition on the ground was very different in detail

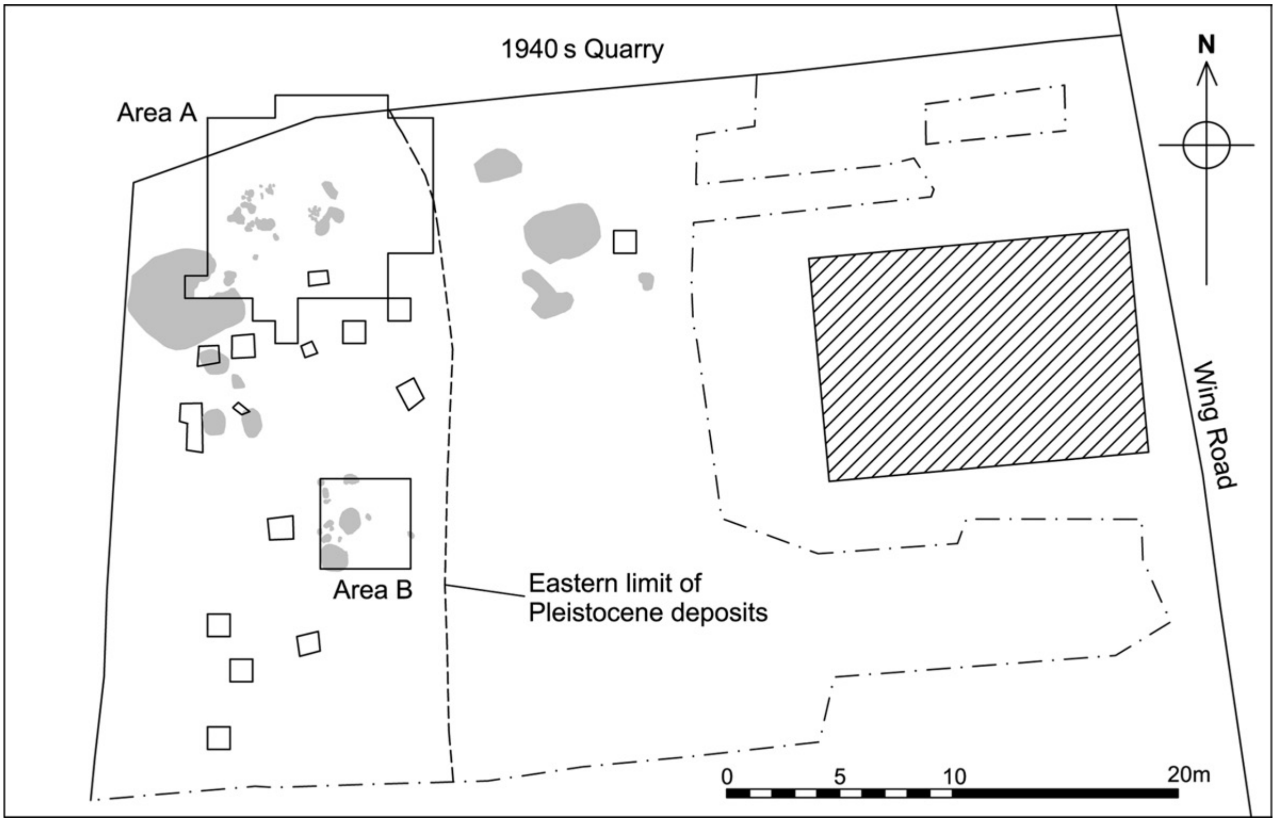

Fig. 4.
The site showing the main areas of excavation and evaluation test pits (sandstone rafts in grey & standing barn hatched).

to the generalised mapping. Most significantly, the carbonate-rich sandstone of the Collyweston Facies was discontinuous, surviving as thin, isolated, or clustered rafts. Today these rafts are relatively flat, although in some cases fairly substantial, the largest on the site being some 5 m across. However, during the mid-Devensian these rocky outcrops would have been prominent features in the landscape.

The Pleistocene deposits were reworked fine sands of the Grantham Formation substrate. Much of the structure of the Pleistocene context was composed of compartments created through a combination of localised faulting, micrograben, and plastic deformation of surrounding sediments. At least two separate but superimposed generations of faulting were recorded on the site. As a result of these processes over time some of the compartments survived at a relatively high level but deeper, downthrown blocks also occurred.

It is likely that the micrograben system would have already been operative before the palaeontological and archaeological activity took place. Thereafter morphological adjustment kept the remains of the site on the inner rim, away from the erosive environment on the outer hillslope. Although the site remained susceptible to subsequent ground-ice effects, these were not markedly disruptive because the forces could be largely absorbed within the continuously extensional structural context. The downthrow of individual compartments took material beyond the reach of any near-surface erosion and of the worst Holocene erosion and more recent human activity.

Other characteristics at Glaston favoured survival of the Pleistocene remains. The upstanding remnants of the Collyweston sandstone acted as an attractor for both hyaenas and humans at various times, giving this particular point on the hilltop a specific identity as

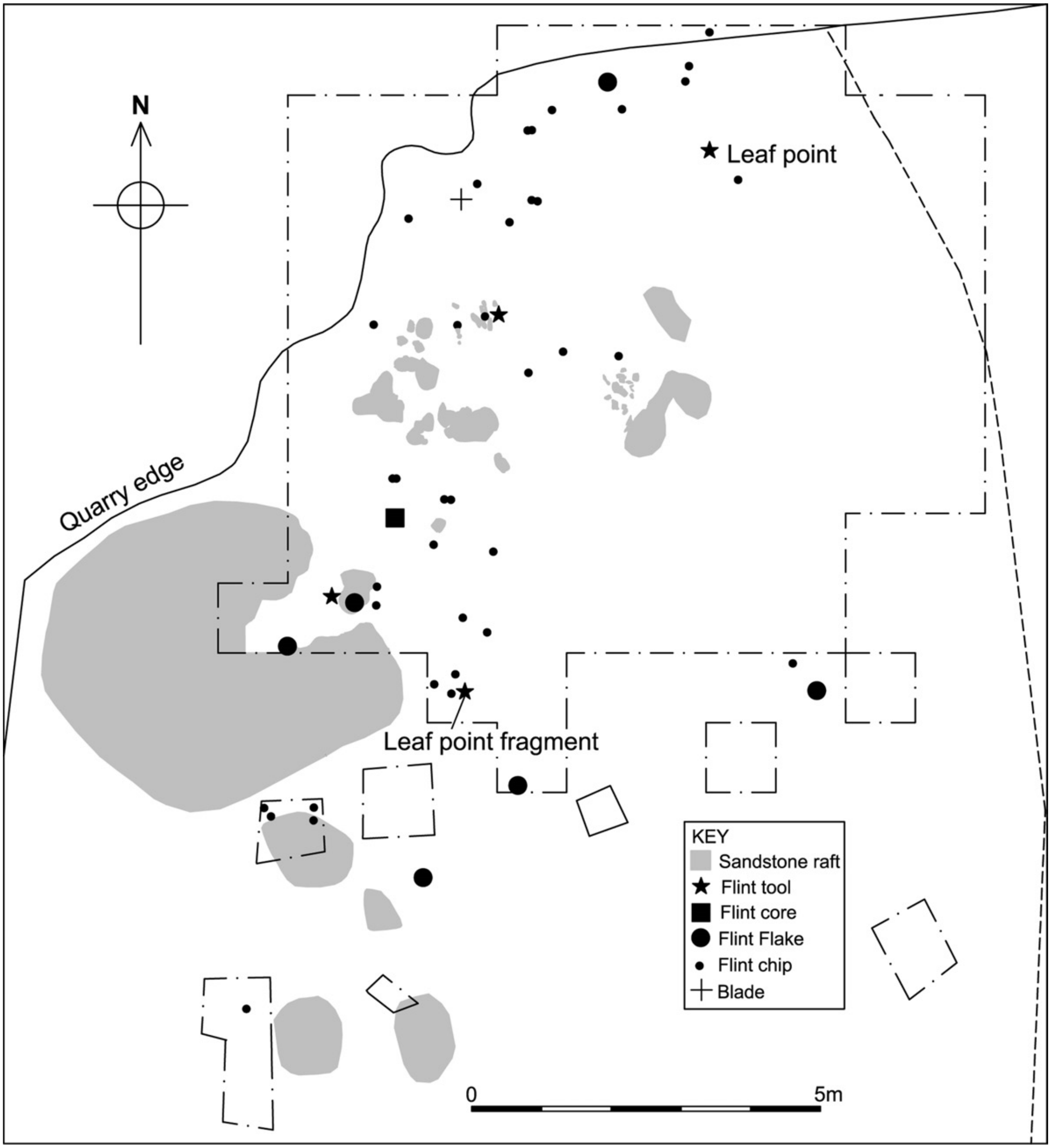

Fig. 5.
Area A – distribution of lithics

well as a little shelter. The proximity of these activities to the sandstone rafts has also helped in the survival of the site. The sandstone is a rich source of carbonate that has been gradually released into the surrounding sands, facilitating good bone preservation. Similarly the fine Jurassic sands provided an excellent matrix for faulting, a ready and mobile surface material in which objects could be buried and a degree of retardation of ice-segregation.

HUMAN ACTIVITY

The flint assemblage comprised 83 pieces (Figs 5–8). Seventy-one lithics were recovered from Pleistocene deposits while 12 pieces from later deposits may also be identified as Upper Palaeolithic due to a distinctive deep patination, compared with Holocene lithics recovered from the later features. The collection includes four tools (a leaf-point, a leaf-point fragment, and two notched flakes), 17 pieces of macro-débitage, and 63 chips (<10 mm). The provenance of the flint is uncertain but appears to be non-local. The broken extremity of the leaf-point reveals a light grey flint, whereas the local till flint is typically yellow-brown or dark brown.

The leaf-point was manufactured on a leaf-shaped blade of triangular section and thus may be termed a blade-point (Jacobi 1990; 2007, following Chmielewski 1961), almost certainly used as a projectile point. Such artefacts have been variously classified by other authors as, for example, partially bifacial leaf-points, Jerzmanowice points, and Lincombe points, as well as others (see references and further examples in Jacobi 2007, 245–7). The dorsal scars show that the blade-point from Glaston was produced from a core with opposed platforms. This created a blank with a very straight longitudinal profile that required only minimal retouching. Jacobi (2007, 247) notes the use of opposed platform cores for this period. These produce relatively straight blanks, essential for controlled flight of a hafted projectile. It is uncertain which end was the tip of the projectile. Both proximal and distal ends of the blade were retouched to a point but the proximal end is more pointed (the tip has been lost to excavator damage (Fig. 6).

There was a fragment of a second leaf-point, part of a base (Fig. 8), displaying the characteristic flat retouch that is typical of British blade-points (Jacobi 2007, 247). The flake appears to have resulted from impact damage, with the flake initiated by contact with its wooden haft producing a hinge-terminating bending fracture. Some leaf-points from the rich earlier Upper Palaeolithic site at Beedings, in West Sussex, show such damage to their bases (Jacobi 2007, fig. 30). In addition there are lateral cone-fractures similar to those reproduced in experimental work on later Upper Palaeolithic type projectile points and observed on archaeological examples from Rekem, a Final Palaeolithic site in north-eastern Belgium (De Bie & Caspar 2000, pl. 110). Such lateral fractures were recorded near the tips of projectile points that had been shot into a deer carcass.

Five trimming flakes were identified and are likely to have been from the on-site blade-point maintenance: their manufacture on site seems unlikely given the paucity of débitage. These were small, thin flakes or chips that have low exterior and high interior platform angles, relatively wide butts with lipping, and, mostly, feathered terminations. Platform preparation for these flakes involved abrasion of the leaf-point margin.

Two other tools were identified, both of which may be classified as notched flakes. One flake has a single 'Clactonian' notch while the other has two contiguous

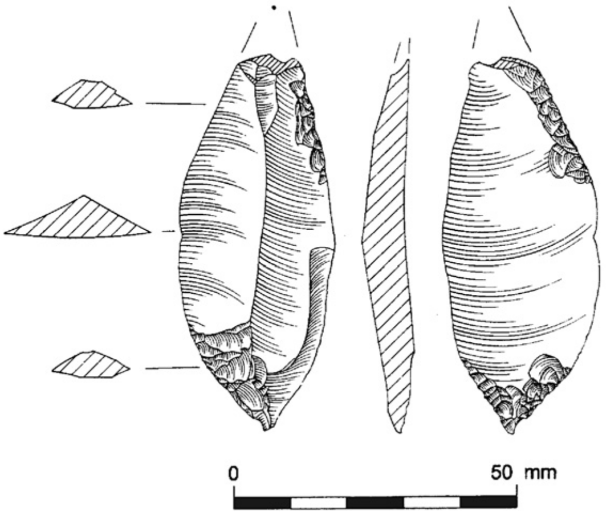

Fig. 6.
Leaf-point

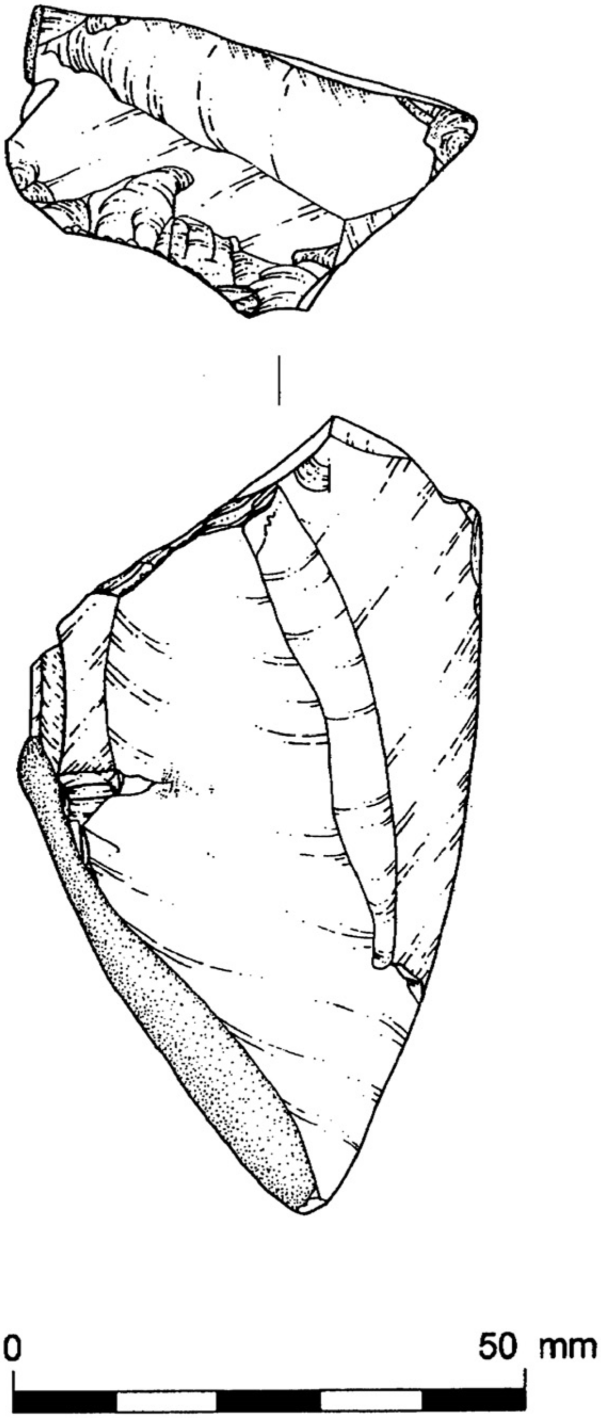

Fig. 7.
Blade core

notches, one direct, the other inverse, and both formed by multiple removals.

An irregular blade appears to be a core rejuvenation flake that removed two previous hinge scars. Its narrow butt is faceted and lipped, typical of soft organic hammer percussion (Pelegrin 2000). The remaining macro-dévbitage comprises flakes.

A blade core fragment, split along a thermoclastic plane, retains some evidence for platform preparation in the form of partial edge faceting. The platform appears previously to have been a core front in that there are two blade scars beneath the edge faceting (Fig. 7).

In close proximity to the blade-point was a group of wild horse limb bones. These were spirally-fractured and there are no signs of hyaena gnawing (Fig. 9). It has been suggested that these may represent the prey of the humans, with fracturing to allow marrow extraction (Thomas & Jacobi 2001, 184). If correctly interpreted these would be the first indications of the prey that humans were exploiting in the north-west peninsula of Europe at this time (Jacobi 2007, 277).

FAUNAL REMAINS

A total of 375 large mammal bones and 2195 identifiable micro-faunal fragments were recovered from Pleistocene deposits representing ten taxa, as summarised in Table 1, the combination of which is characteristic of the mid-Devensian Pin Hole Mammal Assemblage Zone (MAZ) (Currant & Jacobi 2001). The faunal remains provide the best indicator of the contemporary environment and point towards the dry, cool climate with rich arid grasslands of the Eurasian 'mammoth steppe' (Guthrie 1982).

The majority of the bones, particularly those of woolly rhinoceros, had been cracked and chewed by hyaenas (Fig. 10). The faunal remains were scattered across the excavation areas, but included several discrete clusters (Fig. 11). Some of the bone clusters were apparently within collapsed burrows and scrapes, and are likely to represent food caches for hyaena cubs. The presence of juvenile hyaenas is also evident from characteristic gnaw patterns on some of the bones and corroborates the presence of a maternity den. The presence of a wolverine mandible with gastric polishing probably represents

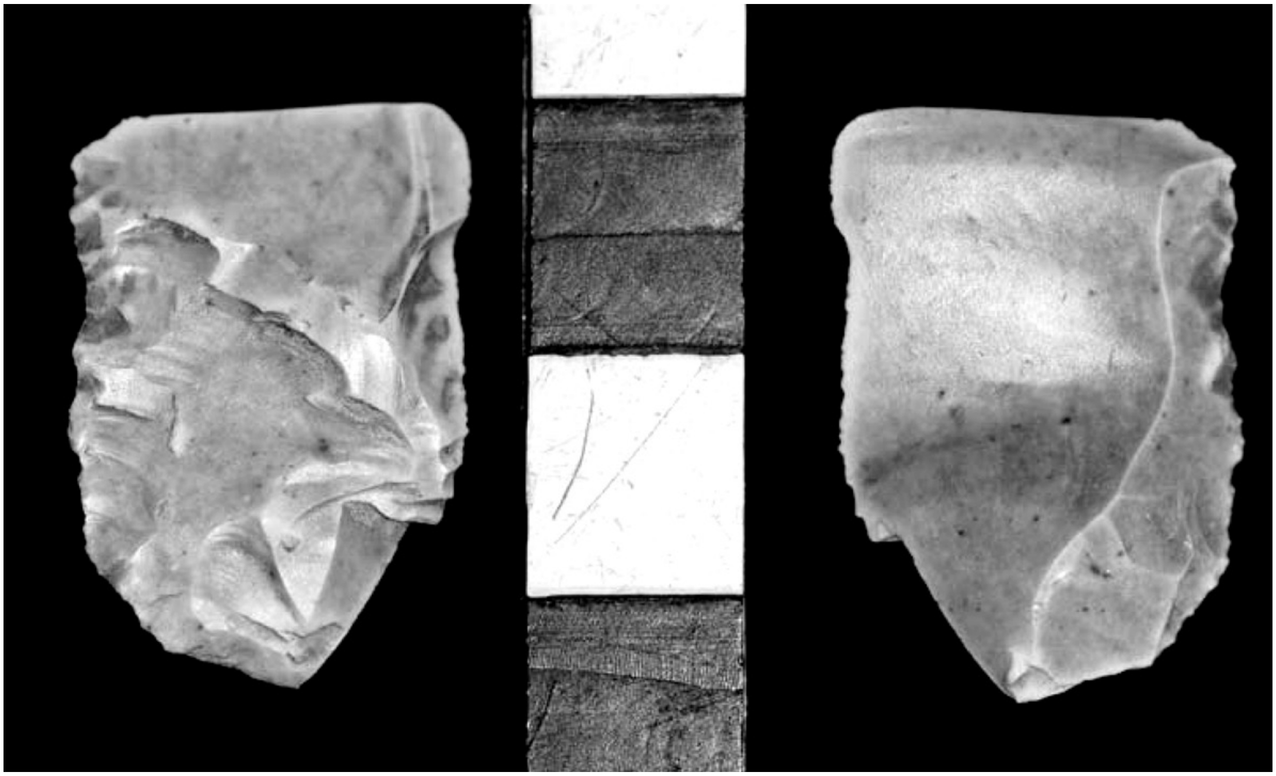

Fig. 8.
The leaf-point basal fragment showing lateral cones of percussion on the ventral face of the flake (right view, right margin)

regurgitated food intended for young hyaena. Behavioural studies have shown that the hyaena young stay at the den while the adults are hunting elsewhere (Sutcliffe 1970, 112).

The largest group, Cluster 1, close to where the leaf-point was discovered, comprised woolly rhinoceros, wild horse, and woolly mammoth (nb, the bones shown on Figure 11 only represent the lowermost finds: unfortunately, the uppermost finds from the initial discovery were not plotted). Pleistocene deposits occurred to a depth of 1.1 m in this area with some structural evidence for a burrow towards the base (Fig. 12). However, the uppermost deposits showed clear signs of faulting. It is suggested that processes of both hyaena burrowing and micrograben faulting came into play. It should be noted that the ungnawed horse limb-bones were found directly above and beneath the leaf-point.

Cluster 2, another well-preserved bone group, was associated with a flint blade that lay directly above a horse cannon-bone. This group comprised a similar range of species but many of the bones appeared less gnawed. Differential weathering was also apparent. While the cluster may have been the result of the micrograben faulting, it is likely that it was also a hyaena food cache in a burrow (Fig. 13).

Cluster 3 included a horse scapula with an apparently embedded, fractured hyaena tooth. The remains lay beneath one of the sandstone rafts in a shallow, linear depression that can be interpreted as the remains of a collapsed burrow. Cluster 4, a smaller group of bones, included reindeer antler fragments, bones, and teeth, was found adjacent to a small group of flints.

There was further evidence of hyaena activity in Area B where several woolly rhinoceros bones were found clustered between and beneath sandstone rafts (Fig. 14). The stratigraphic detail in this area was less

Fig. 9.
Horse limb bones showing articulation (top) and spiral 'twist' fracture, possibly a result of marrow extraction

TABLE 1: SUMMARY OF FAUNAL REMAINS FROM GLASTON, EXPRESSED AS MNI (MINIMUM NUMBER OF INDIVIDUALS)

Taxon	*MNI*
Identified to taxon	
Lepus sp. (hare)	1
Microtus gregalis (narrow-skulled vole)	1
Lemmus lemmus (Norway lemming)	1
Gulo gulo (wolverine)	1
Crocuta crocuta (spotted hyaena)	1
Mammuthus primigenius (woolly mammoth)	1
Equus ferus (wild horse)	3
Coelodonta antiquitatis (woolly rhinoceros)	5
Rangifer tarandus (reindeer)	2
Bos/Bison sp. (bovine)	1

clear than that encountered in Area A and no obvious burrow structures were identified. However, some of the bones may have been cached beneath the rims of the stone rafts.

Discussion of fauna

The condition of the bone varied across the site. In general terms, survival was better from deposits in Area A, although there was some differential weathering. It is possible that some of the better-preserved bones had been buried relatively quickly whilst others remained on the surface to be affected by the elements. Some of the bones recovered from Area A were exceptionally well preserved while others were represented only by the 'ghost' of an outline. Bones recovered from the upper levels of the site also showed signs of surface alteration, largely a result of root etching. Damage inflicted in antiquity is also evident with many bones, particularly those of woolly rhinoceros, displaying gnaw marks. The jaw of a wolverine was polished in appearance resulting from contact with hyaena gastric fluids. A majority of the horse bones have been unaffected by hyaena gnawing. There was no definite sign of human modification such as chop or cut marks. However, many of the horse long bones show spiral or twist fractures that may be due to deliberate breakage by humans for marrow extraction.

The bones provide some measure of contemporary ecological relationships. The most evident of these are

Fig. 10.
'Napkin rings' – all that remains of large Woolly Rhinoceros limb bones following hyaena gnawing. Note the pitted teeth marks on the outer rim of the bone

the remains of the woolly rhinoceros, wolverine, and woolly mammoth, all of which had fallen prey to spotted hyaenas. Gnawed and ingested bones of these animals were found in several discrete locations, often adjacent to or beneath the sandstone rafts. It is feasible that some of the bones were scavenged from human kill sites with the subsequent gnawing of the bones removing evidence for cut marks. The possibility of a sympatric relationship between hyaena and humans can also be suggested (White & Pettitt 2011) and will be explored further below.

Preliminary study of the condition of the small mammal bones (Williams 2007) has demonstrated partial digestion, indicating introduction to the site as scats. On the basis of comparative study of degree of bone digestion it is suggested that the micro-faunal remains were not digested by raptors or by hyaenas, but could be proxy evidence for the activities of a small carnivore such as wolverine or fox. It is quite possible that the hyaenas took over a wolverine or fox den.

DATING

AMS radiocarbon assay was undertaken at the Oxford Radiocarbon Accelerator Unit (ORAU), University of Oxford. Oxford has applied an ultrafiltration protocol based on Brown *et al.* (1988) since 2000, which has been shown to dramatically improve both the quality of the extracted collagen and the accuracy of the resultant measurements (Higham *et al.* 2006; Jacobi *et al.* 2006).

Bones in close proximity to the leaf-point, in context 193, were chosen for the dating programme. The bones were located a maximum of 200 mm above theprincipal leaf-point artefact and laterally within 500 mm. Prior to dating, a large screening programme was undertaken to ensure that bone with sufficient remaining protein was identified. The bone preservation at the site was varied and many of the bones disclosed low levels of nitrogen, which is strongly linked with a predicted lack of extractable collagen (Brock *et al.* 2010a). Twenty bones were tested, and those in Table 2 were those selected for fuller collagen extraction treatment. Samples were prepared using the methods outlined in Brock *et al.* (2010b).

The radiocarbon ages BP and associated analytical data are shown in Table 2. The analytical parameters are all within the ranges of acceptability used at the ORAU. There are two results that were obtained on the same bone (OxA-21311 & 21312) which disclosed statistically distinguishable results at 68.2% probability. There is no ready explanation for this based on the analytical data, which is essentially identical for both pretreated samples. The two overlap at 95.4%, however, when viewed as calendar year ranges (Fig. 15).

We calibrated the radiocarbon data using OxCal 4.1 (Bronk Ramsey 2009a) and the new INTCAL09 calibration curve (Reimer *et al.* 2009), which extends to the limit of the method (Table 3). We modelled the results using a Bayesian approach in order to determine the probability distribution most likely to correspond to the age of the leaf-points. An outlier detection protocol was applied in OxCal to assess whether any of the samples were statistical outliers (Bronk Ramsey 2009b). Each likelihood was given a prior probability of 0.05 of being an outlier within the model. We ran the models assuming of the dates derived from a single phase of activity and assumed that the leaf-point was co-eval within this phase. This assumption may not hold true of course, in fact one of the determinations seems a little later than the others. We included a Date command within the phase to determine the likely age range of the leaf-point. The model gave a range of 43,150–41,260 cal BP (68.2% prob.) and 44,170–40,080 cal BP (95.4% prob.) for the leaf-point with outlier analysis giving a result of 18% outlying (prior 5%).

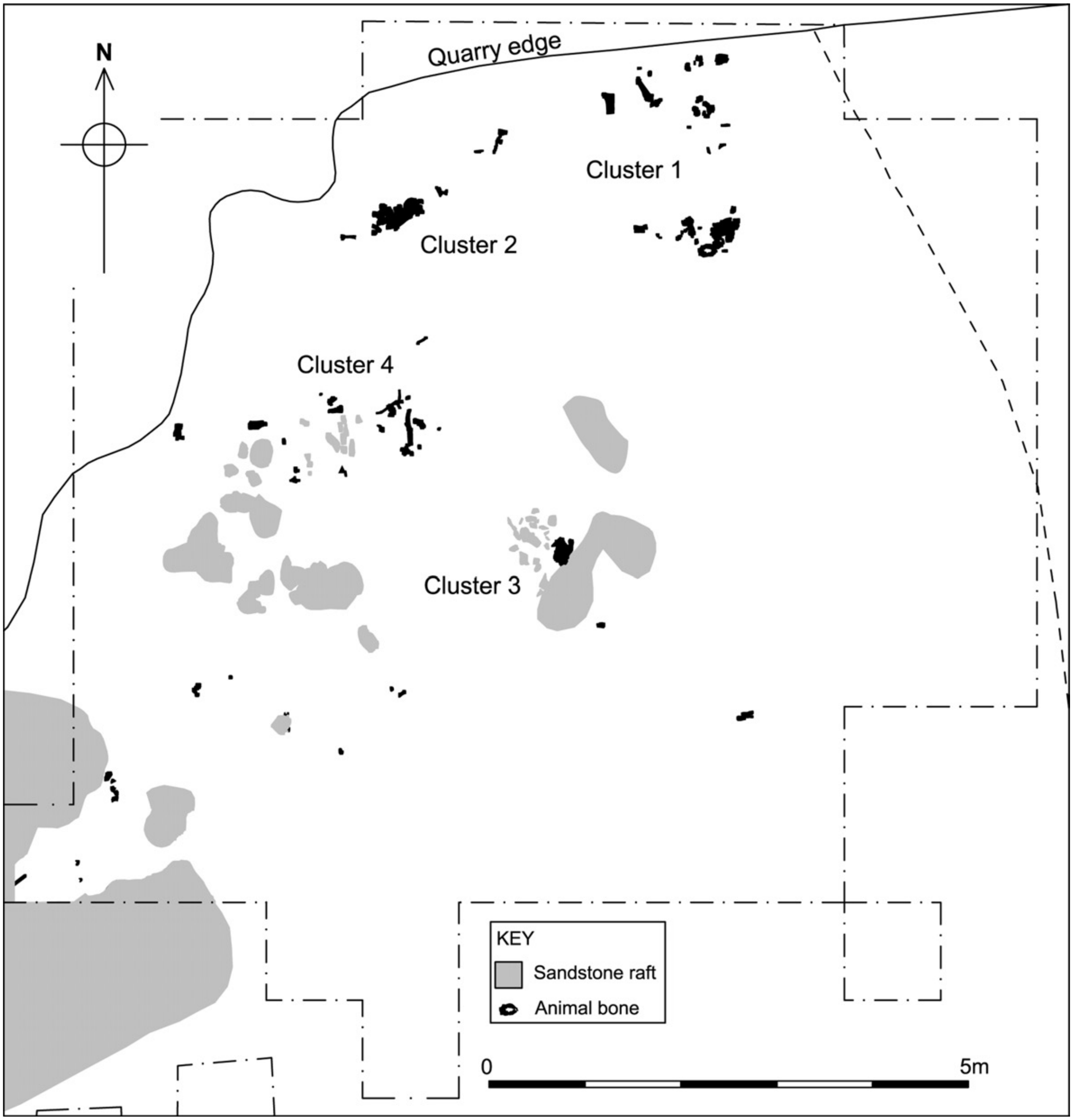

Fig. 11.
Area A – distribution of animal bone

We tested the sensitivity of the model with respect to the inclusion of OxA-21408. We increased the outlier probability to 50% and ran the model again. Determinations with high prior and posterior outlier probabilities are automatically downweighted in the models. The model produced an outlier probability of 79% for OxA-21408 and the date inferred for the leaf-point was 43,200–41,990 cal BP (68.2% prob.)

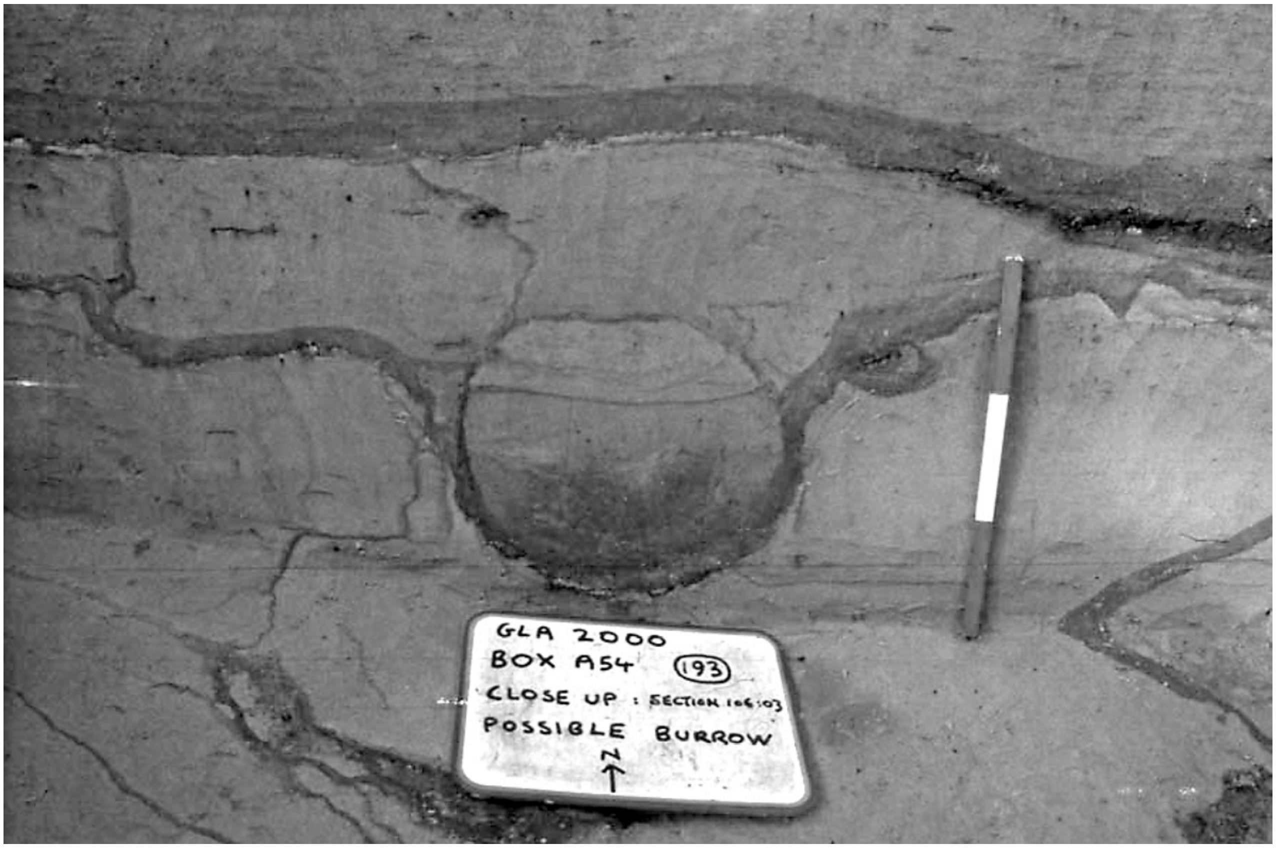

Fig. 12.
Cross-section of the hyaena burrow feature

and 43,940–40,510 cal BP (95.4% prob.). The results are not significantly different.

The results tend to support the chronology proposed by Jacobi *et al*. (2006), which suggests, based on a small group of dates from other contexts and sites principally in the British Isles, that leaf-points appear to date around 36,000–38,000 BP (~41–43,000 cal BP) in radiocarbon terms. All of the six dates obtained at Glaston within close association with the leaf-point remains are identical to this.

The results were compared tentatively against the NGRIP δ^{18}O palaeoclimate curve of Andersen *et al.* (2006) and Svensson *et al*. (2006). The question of global synchroneity in climatic variations has yet to be fully answered and counting errors in the icecore records are cumulative, although fully quantified, and therefore approach millennial scales through the last glaciations. What is interesting, however, despite this corollary, is that the determinations from Glaston appear to fall within GIS-11 on the NGRIP record. This might suggest a presence of humans during a warmer phase of the last glaciations.

DISCUSSION

The focal point for both humans and hyaenas would seem to have been the ridge crest. The hyaenas could have taken advantage of the large outcrop of sandstone rafts and the underlying sands that created perfect conditions for den creation. Both humans and hyaenas may have occupied the site due to its position as a vantage point for monitoring potential prey. At the project's inception it was reported that the site offered a wide panorama of the ridge as well as into the flanking valleys below (Thomas & Jacobi 2001,

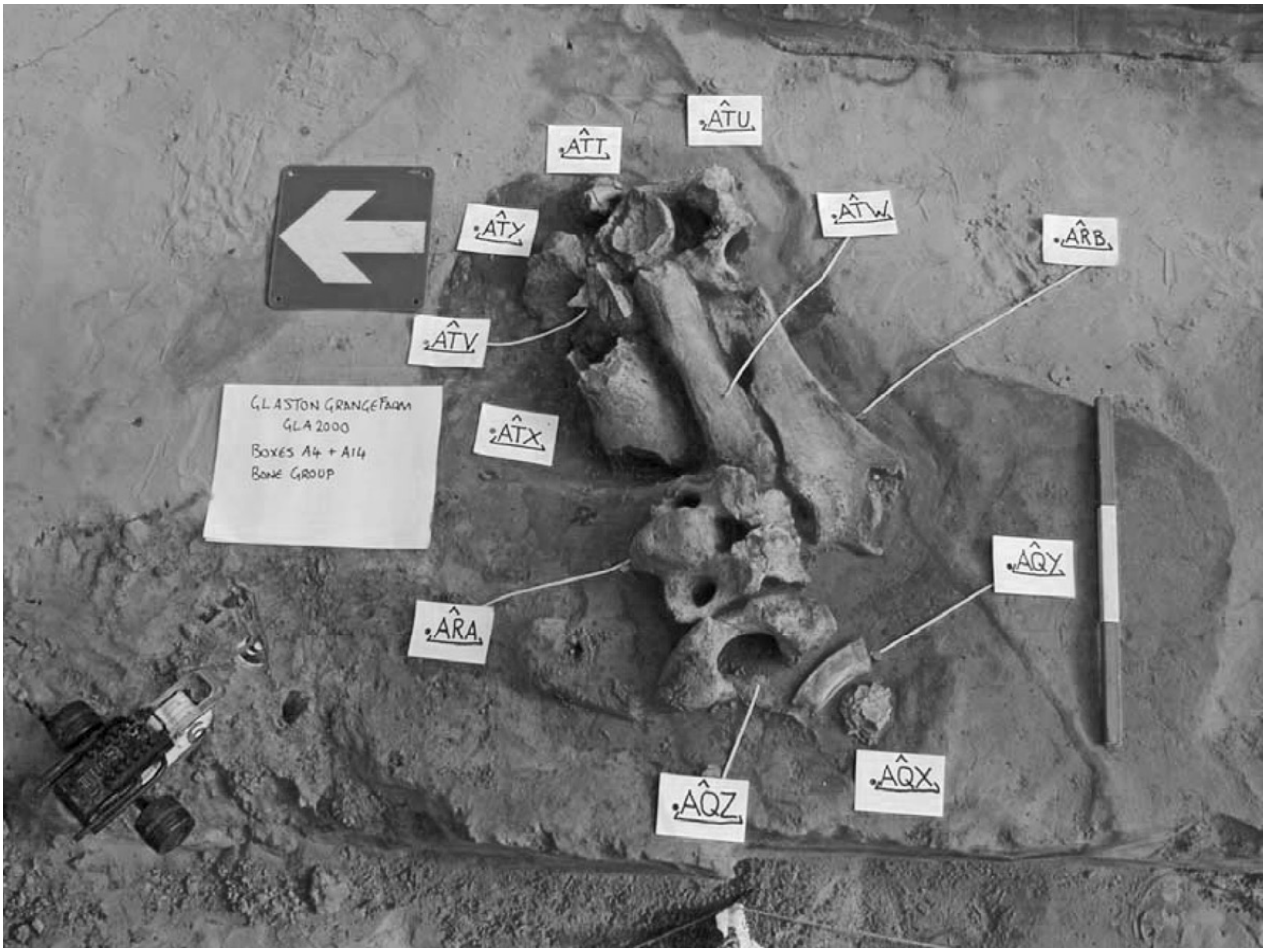

Fig. 13.

Bone Cluster 2 showing the closely associated rhinoceros and horse bones, possibly accumulated in a collapsed burrow. To the north-west, a model racing car was one of several (*c.* 1970s) toys that lay within a modern animal burrow providing a more recent example of how such features can accumulate artefacts

182). However, viewshed analysis in a GIS model of the environs demonstrated limited views into the valley sides, but an excellent vista of the ridge plateau, and the flanking plateaux of the adjacent interfluves (Figs 16 & 17).

The hyaenas left an accumulation of bone from species typical of the Pin-Hole MAZ type (Currant & Jacobi 2001) including hare, wolverine, woolly mammoth, wild horse, woolly rhinoceros, and reindeer. There were some indications for the presence of young hyaenas suggesting that, at least at some point, it was used as a maternity/nursery den. The humans left a scant signature, a small assemblage of lithics including a leaf-point and a basal fragment from a second example. It is also suggested that the humans were responsible for the horse bones in Cluster 1. The production or mending of leaf-points at the site is suggested by a few trimming flakes. The good condition of lithics and faunal remains and their physical and stratigraphic associations would suggest that the human and hyaena occupations be seen as near contemporary.

A characteristic of MIS 3 in the UK is the ubiquitous presence of hyaena up to 30 kyr BP and

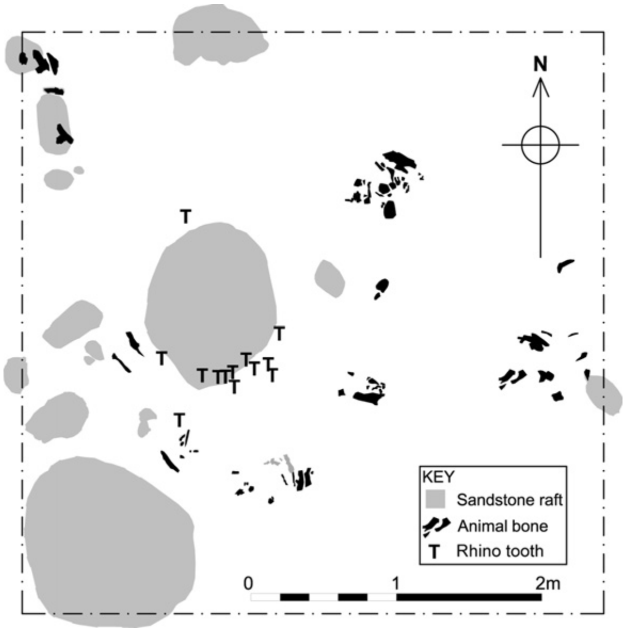

Fig. 14.
Area B – distribution of animal bone

extending back beyond 40 kyr BP (White & Pettitt 2011, table 6). Many cave sites have evidence for Middle and Early Upper Palaeolithic usage juxtaposed with evidence of hyaena denning, a situation that might indicate a direct ecological relationship (Dusseldoep 2011; White & Pettitt 2011, 52; Pettitt & White 2012a, 324). Indeed, it is quite plausible that the two species had a sympatric relationship with one species on occasion being the predator, the other the scavenger and *vice versa*. It is our opinion that Glaston presents evidence for such, ie, a unique open-air site comprising a hyaena maternity den and an Upper Palaeolithic hunting and foraging stand where such a ecological relationship can be inferred: the humans exploiting the hyaena den for economic reasons, foraging for meat caches at a maternity den, a situation envisaged by White and Pettitt (2011, 52) and Pettitt and White (2012a, 324).

The blade-point is the typological marker of the north European Lincombian-Ranisian-Jerzmanowician techno-complex (Desbrosse & Kozlowski 1988; Jacobi 2007) and recently abbreviated to the LRJ by Flas (2001; 2002; 2006). This term incorporates several earlier, local classifications and hints at their geographical spread from western Britain to Poland. It is not the intention here to rehearse the history of discoveries and classifications as these have been covered exhaustively by recent studies and publications (Flas 2001; 2002; 2006; Jacobi 2007). Commonly the LRJ is perceived as the earliest stage of the earlier Upper Palaeolithic on the North European plain, though there are reasons to believe the LRJ may have been the product of final Neanderthals rather than early anatomically modern humans. It has been suggested that blade-points evolved from fully bifacial leaf-points and these would appear to have their roots in the north European Middle Palaeolithic (Otte 1990; Kozlowski 1990). However, others have been more cautious such that Hopkinson (2007, 50) ignored 'transitional' assemblages in his recent study of Middle Palaeolithic leaf-points, while Pettitt (2008, 27–8) has even entertained the notion that leaf-points may have been used by both species. Jacobi (1990; 2007) stressed the linkage of north European leaf-point industries or, latterly, the LRJ to prismatic blade technology, even using the term blade-point as a synonym for leaf-point.

Recent reviews of the limited dating evidence for stratified LRJ assemblages suggest that they occur some millennia before the arrival of the earliest Aurignacian in north-west Europe and are therefore associated with Neanderthals (Jacobi 2007; Semal *et al.* 2009). At Nietoperzowa cave, Jerzmanowice, Poland the earliest LRJ layer was dated to *c.* 38,500 BP (Chmielewski 1961), while in the UK the most reliable dates suggest a date of *c.* 38–36,000 BP (Jacobi 2007), certainly in excess of 35,000 BP (Jacobi *et al.* 2006). The dated bone from Glaston at *c.* 38,000 BP (42–44 kyr cal BP), associated with a leaf-point, provides strong support for such an early date. There is a clear sequence at the Ilsenhöhle, below the Castle of Ranis in Thuringia, where LRJ deposits underlie an Aurignacian layer (Hülle 1977). The recent radiocarbon dating of Neanderthal burials from the cave of Spy, in eastern Belgium (Semal *et al.* 2009) also supports the notion that the LRJ was made by Neanderthals. However, there have been recent claims for an earlier Aurignacian in north-west Europe based upon dated fauna found in association with the Kent's Cavern KC4 mandible (Higham *et al.* 2011), but the association has been questioned in some quarters (Pettitt & White 2012b).

The association of Neanderthals with the oldest stage of the north European Early Upper Palaeolithic,

TABLE 2: AMS RADIOCARBON DETERMINATIONS FROM GLASTON

OxA	*Conventional radiocarbon age* BP	*Sample*	*Species*	*Start weight (mg)*	*Yield (mg)*	*% Yield*	*%C*	*$\delta^{13}C$ (‰)*	*$\delta^{15}N$ (‰)*	*CN atomic ratio*	*%N whole bone*
21308	35610 ± 300	GLA 2000 AIC A54	Gnawed diaphyseal frag.	1006.2	51.8	5.1	44.2	-18.5	5.0	3.4	0.6
21309	38120 ± 360	GLA 2000 AAQ 193	*Coelodonta antiquitatis* gnawed midshaft r. humerus	1010.7	70	6.9	42.8	-19.9	4.3	3.3	1.3
21310	38800 ± 390	GLA 2000 AAP 193	*Coelodonta antiquitatis*- gnawed midshaft l. humerus	1007.2	74.95	7.4	42.4	-19.7	4.2	3.3	1.2
21311*	37380 ± 350	GLA 2000 AAC 193	*Equus ferus* 1st phalange	1003	43.32	4.3	42.5	-20.6	3.9	3.3	0.7
21312*	38610 ± 400	GLA 2000 AAC193	*Equus ferus* 1st phalange	1000	43.02	4.3	42.3	-20.5	4.1	3.3	
22149	38400 ± 900	AAR 193	*Coelodonta antiquitatis* gnawed midshaft l. tibia	610	30.2	5	46.1	-20.3	4.3	3.2	0.6

* Denotes duplicate measurements

Stable isotope ratios are expressed in ‰ relative to vPDB and nitrogen to AIR. Mass spectrometric precision is ±0.2‰ for carbon and ±0.3‰ for nitrogen. Gelatin yield represents the weight of gelatin or ultrafiltered gelatin in milligrams. %Yield is the percent yield of extracted collagen as a function of the starting weight of the bone analysed. %C is the carbon present in the combusted gelatin and is usually around 40–45% in well preserved collagen samples. CN is the atomic ratio of carbon to nitrogen. At ORAU this is acceptable if it ranges between 2.9 and 3.5. The %N whole bone refers to the % of N in the bone prior to pretreatment. This is used to scan suitable bone samples from a batch of potential samples. We tested 20 bones from Glaston. Only two were >1%N, the remaining were mainly <0.6. At ORAU, bone <0.76% is generally not dated (Brock *et al.* 2010b). Modern bone is about 4–4.5% N.

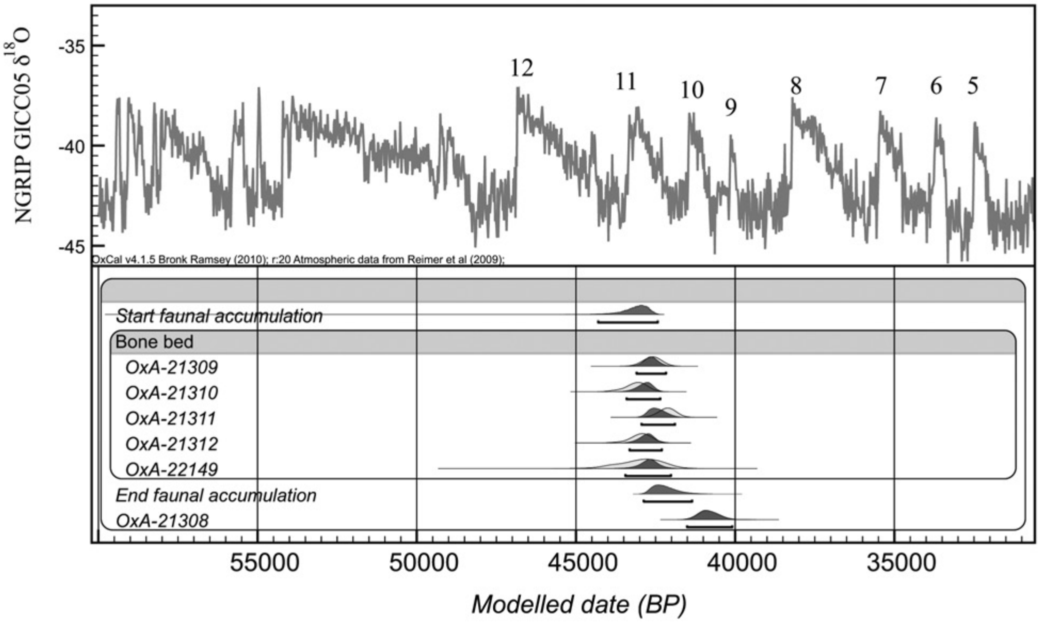

Fig. 15.

Calibrated radiocarbon data and age modelling for the Grange Farm AMS determinations (produced using OxCal 4.1 (Bronk Ramsey 2001). The calibrations were obtained using INTCAL09 (Reimer *et al.* 2009). Numbers alongside the oxygen isotope curve refer to Greenland Interstadials (GIS)

TABLE 3: CALIBRATED AGE RANGES (BP) OBTAINED USING INTCAL09 (REIMER et al. 2009) AND OXCAL

	Calibrated age range BP *(68.2% prob.)*		*Calibrated age range* BP *(95.4% prob.)*	
	from	*to*	*from*	*to*
OxA-21308	41190	40530	41500	40110
OxA-22149	43530	42150	44380	41700
OxA-21312	43260	42590	43720	42270
OxA-21311	42400	41840	42710	41580
OxA-21310	43410	42710	43900	42450
OxA-21309	42890	42300	43190	42030

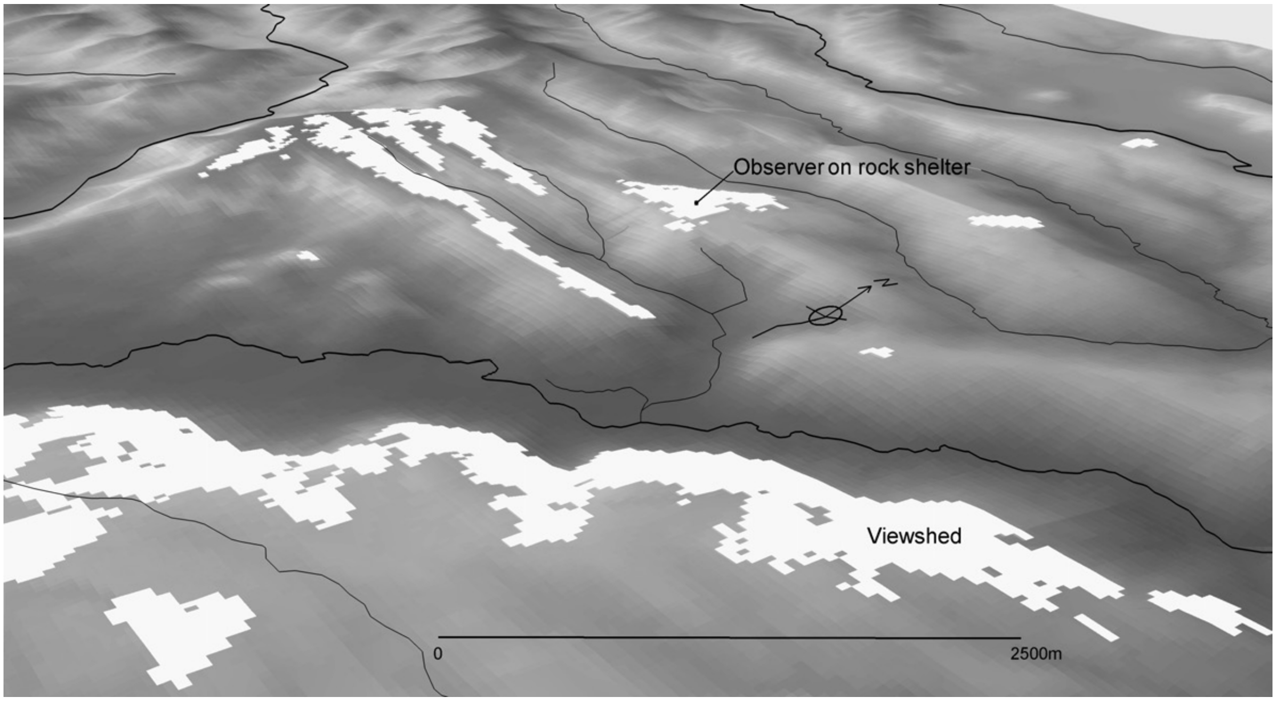

Fig. 16.
Viewshed for observer with line of sight 3 m above recorded surface in location of rock shelter. Object height of 1.5 m. © Crown Copyright/database right 2009. An Ordnance Survey/Edina supplied service

identified by prismatic blade technology, should not be surprising. If there is a chronological hiatus between the last Neanderthals and earliest modern humans in northern Europe it would imply that the technology was an independent development rather than acculturation from modern humans (Otte 1990; Semal *et al.* 2009). Similar views have recently been presented by Zilhão *et al.* (2008) with regard to the 'transitional' industry of the Châtelperronian. Indeed, prismatic blade technology has been associated with earlier MIS 5 Neanderthals in northern France and Germany (Conard 1990; Ameloot-van der Heijden 1993) but the technological innovation was short-lived probably due to the lack of a viable metapopulation (Hopkinson 2011). Should there be some overlap between the latest Neanderthals and the earliest anatomically modern humans there are other reasons to place the authorship credits of the LRJ with

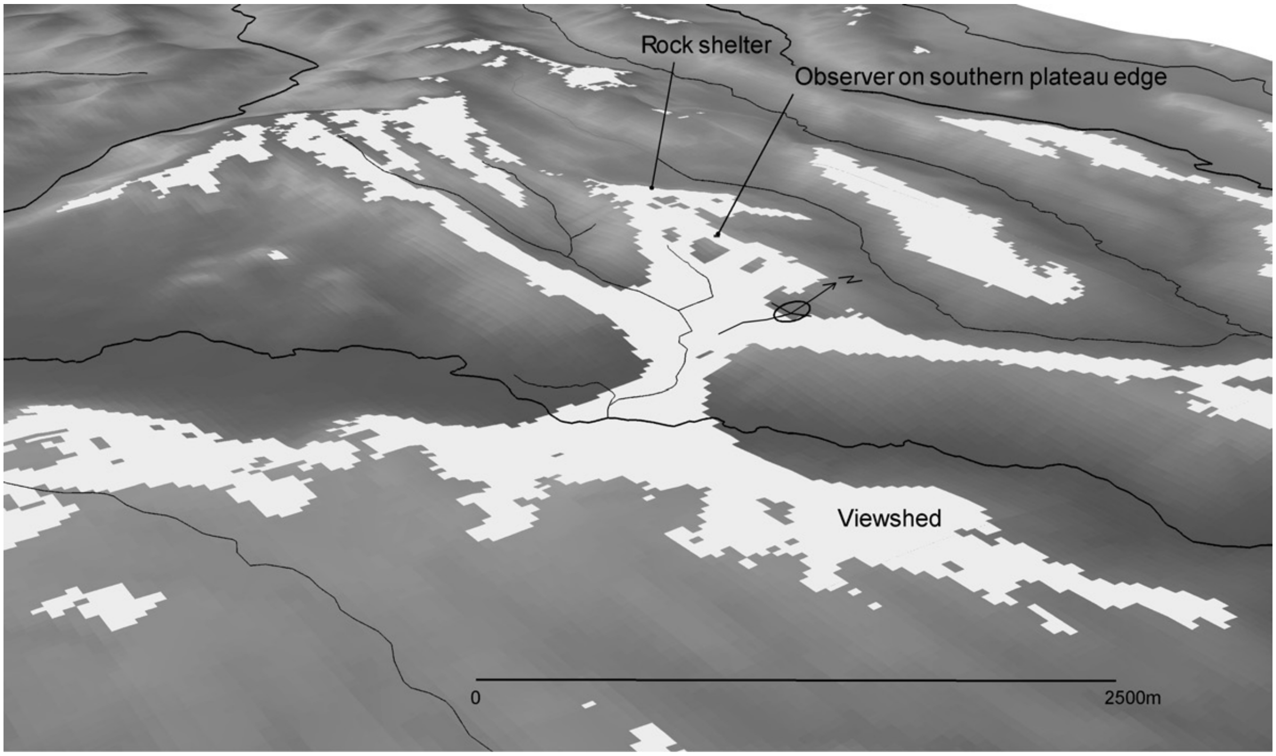

Fig. 17.
Viewshed for observer standing some 900 m east of the rock shelter on southern edge of plateau, with line of sight 2 m above recorded surface. Object height of 1.5 m. © Crown Copyright/database right 2009. An Ordnance Survey/Edina supplied service

the latest Neanderthals. There are distinct differences of blade production technologies between the LRJ and the Aurignacian (Flas 2011, 614). The LRJ blades, the blanks for leaf-point production, were made on cores with opposed platforms; alternate removals produced blades with rectilinear shape. The Aurignacian blade technology used cores with a single preferential platform, thus producing blades with a curved profile. Furthermore, there are distinct geographical differences in the distribution of sites belonging to the two traditions and in the few cases where LRJ and Aurignacian artefacts are found together there are no convincing associations e.g. Kent's Cavern (White & Pettitt 2011, 83–5).

There are some 30-odd LRJ sites that spread from Wales to Poland across the North European plain and there is a distinct majority of sites in England and Wales (85%) compared with the continent (Semal *et al*. 2009, fig. 5). Jacobi (2007, 278), noting the preponderance of sites, concludes that the British Isles must have been 'especially favoured hunting grounds' with significant animal populations. Pettitt (2008, 27–8) has suggested that the LRJ had its cultural origins to the east, while Stapert (2007) has amplified this notion and suggested that the skewed distribution may reflect a mass migration of late Neanderthals on a 'great trek' from the east following pressure from an influx of anatomically modern humans. However, the higher proportion of sites in the British Isles also raises the question of the cultural origin of the LRJ. Local technological innovation by late Neanderthals appears to have occurred earlier in the mid-Devensian: *bout coupé* or Coygan type handaxes can be seen as an innovation in the area currently known as the British Isles (White & Jacobi 2002). Perhaps the leaf-point techno-complex also had its origins in the western part of the north European Plain (Pettitt & White 2012, 394)?

CONCLUSION

The Glaston site has provided a new context for the study of mid-Devensian humans in the form of an open-air station at the site of a hyaena den. We have suggested that the association of hyaena and human is direct and that we have an archaeological signature of a maternity den targeted by humans for scavenging hyaena food caches (Pettitt & White 2012a, 324).

The archaeological excavations have demonstrated the great potential for ridge-top grabens being repositories for fragile archaeological remains. Jones (2002) has suggested that graben structures, of similar magnitude to the Glaston example, extend across the ridges of the Jurassic Stone belt in the region. Collcutt (2001) stated that the Glaston archaeological survival was not capricious and has speculated that similar repositories may be found across the UK. Indeed similar deposit traps include gulls and fissures such as those preserving earlier Upper Palaeolithic deposits at Beedings, Pulborough, West Sussex (Jacobi 1986; 2007). Of course, an additional taphonomic factor at Glaston was the burrowing activities of hyaenas.

In considering the mid-Devensian archaeology in what is now the UK White and Pettitt (2011, 88; 2012a, 399) have been dismissive of the results of early excavations stating that new sites and an increased focus on fieldwork is 'sorely needed'. This is beginning to happen with recent research excavations in the UK at Creswell Crags (Pettitt *et al*. 2009), Kent's Cavern (Pettitt & White 2012c), and Beedings (Pope 2007/8). The Glaston site is testament to the fact that developer-funded archaeology can also contribute to such research and begins to answer the call for 'new examples of leafpoints, excavated and recorded with modern methods, and ultra-filtrated radiocarbon dates on associated fauna' (White & Pettitt 2011, 86).

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