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Mapping the human record in the British early Palaeolithic: evidence from the Solent River system

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ABSTRACT: The lithic record from the Solent River and its tributaries is re-examined in the light of recent interpretations about the changing demography of Britain during the Lower and early Middle Palaeolithic. Existing models of the terrace stratigraphies in the Solent and its tributary areas are reviewed and the corresponding archaeological record (specifically handaxes) for each terrace is assessed to provide models for the relative changes in human occupation through time. The Bournemouth area is studied in detail to examine the effects of quarrying and urbanisation on collection history and on the biases it introduces to the record. In addition, the effects of reworking of artefacts from higher into lower terraces are assessed, and shown to be a significant problem. Although there is very little absolute dating available for the Solent area, a cautious interpretation of the results from these analyses would suggest a pre-Marine Isotope Stage (MIS) 12 date for the first appearance of humans, a peak in population between MIS 12 and 10, and a decline in population during MIS 9 and 8. Owing to poor contextual data and small sample sizes, it is not clear when Levallois technology was introduced. This record is compared and contrasted to that from the Thames Valley. It is suggested that changes in the palaeogeography of Britain, in particular land connections to the continent, might have contributed to differences in the archaeological records from the Solent and Thames regions. Copyright © 2009 John Wiley & Sons, Ltd.

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KEYWORDS: Solent River; Palaeolithic; demography; terrace stratigraphy; handaxes; Levallois.

Introduction

One of the main thrusts of recent research in northern Europe has been the mapping of human presence and absence during the Pleistocene and how this has been affected by climate, environment and, in the case of Britain, by recurrent changes in status from peninsular to island (e.g. Gamble, 1987, 1992; Roebroeks *et al*., 1992; White and Schreve, 2000; Ashton and Lewis, 2002). Britain has one of the best records against which to test models of human presence together with changes in population, settlement and technology through time. Although the record from primary context sites has often provided the fine-grained detail of human behaviour and habitat (Roberts and Parfitt, 1999; Ashton *et al*., 2006), the secondary context sites from the fluvial archives also provide a valuable coarse-grained record of shifts through time (Bridgland, 1994; Ashton and Lewis, 2002). These archives consist of stone artefacts in well-mapped terrace sequences, which can be used to investigate the first appearance of humans and the introduction of new technologies (Bridgland, 2001; Westaway *et al*., 2006).

These archives have also been used to examine changes in population and investigate the effects of the insularity and peninsularity of Britain (Ashton and Lewis, 2002). Long-standing models of the formation of the Strait of Dover have suggested that they were formed at the end of Marine Isotope Stage (MIS) 12 (Smith, 1985; Gibbard, 1995), so that Britain could only have been reached by land during cooler episodes after this point. There has also been the recognition of an absence of human populations in Britain from at least MIS 6 through to the end of MIS 4 (Stuart, 1976; Currant, 1986; Wymer, 1988; Currant and Jacobi, 2001; Ashton, 2002). In order to test the interpretations of human absence, Ashton and Lewis (2002) examined the Middle Thames and used artefact densities within the terraces as a proxy for human population. The results suggested that, at least in that area, not only were populations very small or absent from MIS 6–4, but also that there was a general decline in population from MIS 11 through to MIS 7. On this basis they suggested that the breach of the Dover Strait might be later in time, possibly at the end of MIS 8 or MIS 6. These conclusions have been partly supported by more recent work using bathymetry of the English Channel and

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southern North Sea Basin (Gibbard, 2007; Gupta *et al.*, 2007), which has led to the suggestion of a more recent, or possibly a second, breach at the end of MIS 6. A later breach of this type would totally change the dynamics of human population movements into and out of Britain.

The reasons for the apparent drop in population from MIS 6 onwards are now perhaps better understood because of the increasing evidence for the climatic severity of MIS 6 and a second post-MIS 12 breach. However, the suggestion that population declined from MIS 11 through to MIS 7 has received less support (Hosfield, 2005; Scott, 2006; White *et al.*, 2006; McNabb, 2007). A variety of possible reasons for the decline in artefact numbers has been suggested. Ashton and Lewis (2002) suggest that this does reflect population and that one possible reason is the increasing adaptation of Neanderthal populations to open steppe environments, which were less prevalent in Britain than in eastern Europe. Hosfield (2005) and McNabb (2007) suggest that the pattern of artefact decline is not reflected in the Solent area and that the effects of collecting history play a role. Hosfield further suggests that regional differences in the archaeology might be a factor. In contrast, Scott (2006) and White *et al.* (2006) argue that changes in technology and landscape use during the early Middle Palaeolithic produces a shift in artefact discard away from raw material sites in the river valleys to a broader range of sites beyond, reducing artefact numbers in the fluvial record.

To test the validity of the data from the Middle Thames and to examine these different hypotheses, a fresh look is taken at the archive from the rivers of the Hampshire Basin, including the former Solent River. This archive is also examined to contribute to the wider Palaeolithic debates on the first arrival of humans and the introduction of Levallois technology to Britain.

The Hampshire Basin

The Hampshire Basin has been recognised as an area rich in Palaeolithic archaeology since the late 1860s. The vast majority of the archaeological record derives from the fluvial sands and gravels of the former Solent River and its principal tributaries, the Rivers Frome, Stour, Avon and Test (Fig. 1). The lithic assemblages were predominantly collected in the later part of the 19th and earlier decades of the 20th centuries. Although these collections have been listed in gazetteers and occasionally described in more detailed papers (e.g. Burkitt *et al.*, 1939; Calkin and Green, 1949; Roe, 1968; Wessex Archaeology, 1993; Wymer, 1999), it has only been over the last 10 years that serious attempts have been made to understand better the overall nature and dating of the archaeological record (e.g. Hosfield, 1999, 2001; Bridgland, 2001; Wenban-Smith, 2001; Briant *et al.*, 2006, 2009b; Westaway *et al.*, 2006).

One of the difficulties in understanding the archaeological record has been the differing schemes used to map the terraces in the Solent and the different tributary areas and between the lower and higher reaches of individual rivers, but also the occasional lack of agreement over the reinterpretation of these schemes. This has caused confusion and has complicated archaeological interpretation.

A further problem has been the dating of the terraces in different areas. With the paucity of biological remains within the sediments it has been difficult to use biostratigraphy in all but a few cases. Where organic remains are preserved, such as at Pennington Marshes and Stone Point at Lepe, they have always been found in low-lying terraces, attributed to MIS 7 or later. More recently, optically stimulated luminescence (OSL) work has begun to help with the dating of some of the lower terraces, although there is less certainty about the reliability of the dating of higher terraces (Briant *et al.*, 2006, but see Briant *et al.*, 2009c; Briant and Schwenninger, 2009).

There has also been an attempt to use archaeology to date the different terraces (Westaway *et al.*, 2006), whereby the first appearance of artefacts, the introduction of Levallois technology and the arrival of *bout-coupé* handaxes have been argued to be tie-points, dated to MIS 15, MIS 9/8 and MIS 3 respectively. However, there are two serious problems with

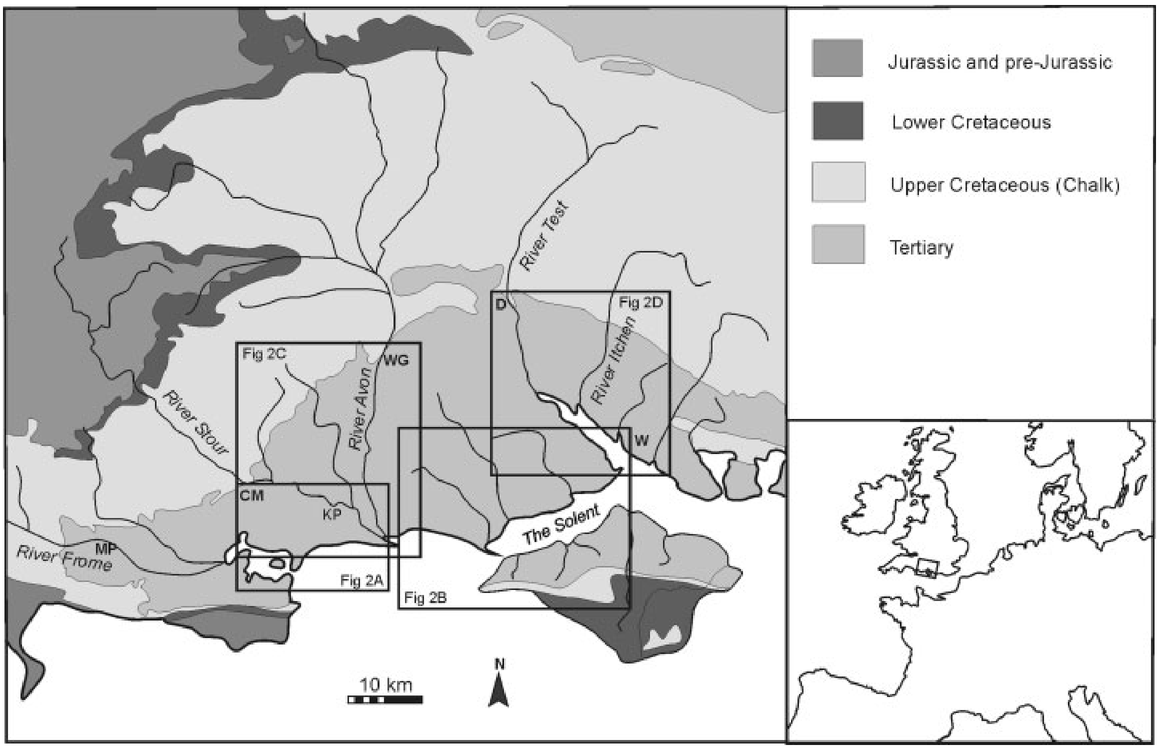

Figure 1 Map of the Hampshire basin showing the Solent and tributary rivers with underlying geology and the key sites discussed in the text. MP, Moreton Pits; CM, Corfe Mullen; KP, King's Park; WG, Wood Green; D, Dunbridge; W, Warsash

the method. The date they use for the first appearance of humans in Britain is based on their reinterpretation of the assemblage at Pakefield (Suffolk) to MIS 15, despite the widely accepted age of MIS 17 or late 19 for this site (Parfitt *et al.*, 2005). There is a further problem in using the introduction of Levallois to date terraces. This is in part due to the low number of Levallois artefacts from the Solent, but also to a lack of scrutiny of the published identifications (Roe, 1968) or of their actual contexts. Specific criticisms of their approach are given in the relevant area studies below. For these reasons the dating put forward by Westaway *et al.* (2006) is not used in this paper.

With the recognition of many of the problems with the Solent data, Hosfield (1999) undertook a thorough review of the archaeological record with the use of GIS modelling to understand the distribution of the archaeology, taking into account the varying processes of archaeological discovery, together with the taphonomic problems of artefact transport and reworking. The results were used to underpin models of human behaviour and landscape use on a local and regional scale.

The current study draws on much of this information together with more recent work, and is primarily aimed at addressing the questions of human arrival, technological change and by using artefact densities identifying possible population changes through time. The relative terrace records in each river system are compared, taking into account the effects of taphonomy, variable collecting histories and the different interpretations of the terrace stratigraphy. A local case study, building on earlier work by Hosfield (2005), is presented of the Bournemouth area where the terrace mapping of Allen (1991; Allen and Gibbard, 1993) is in broad agreement with that of Bristow *et al.* (1991) and where collection history is better understood.

Methods

The study is based on the listing of sites with artefact numbers published in the Southern Rivers Palaeolithic Project (SRPP; Wessex Archaeology, 1993), with occasional additions found from new studies of collections and archives. Some assemblages have also been examined first-hand, particularly from the Bournemouth area (supporting information: Table 1). The vast majority of assemblages were collected, rather than excavated, during the latter part of the 19th and earlier part of the 20th centuries. For this reason nearly all the collections are biased towards handaxes, rather than flakes, with only 67 Levallois artefacts from the entire area. Although the low quantity of Levallois material might be due to biases in collection, in the Thames catchment, which has a similar collecting history, large Levallois assemblages were collected from several major sites. This suggests that the low Levallois counts for the Solent reflect a genuine dearth of Levallois sites in this region. Whether this is a reflection of low population, or that other technologies were used during MIS 8 and MIS 7 in the Solent area, is not clear. Due to these difficulties, handaxes alone are used in the artefact density analysis to study potential population changes. It is assumed that handaxes no longer form a major component of the human technology from MIS 7 onwards, and therefore only terraces likely to be MIS 8 or older are used.

The survival of terrace gravels differs considerably both within and between areas. To factor out biases in survival, each terrace area has been quantified and handaxe densities based on area have been calculated (Table 1). One problem with this method is that the density is not based on volume. Unfortunately, the sparse distribution of boreholes on which the terrace mapping is based, and the wide variation in depth of the gravel as shown by the borehole records (Bristow *et al.*, 1991; supporting information: Table 2), does not allow a realistic estimation of volume. It should also be noted that some of these boreholes did not reach the base of the gravel or recorded truncated terrace sequences. For the purposes of this paper it is assumed that terrace thickness is broadly similar, supported to some extent by the mean values (supporting information: Table 2).

The condition of the artefacts provides important clues to their taphonomic history and the type of sediment in which they were found. The main attributes include rolling, abrasion, staining and patination (cf. Harding *et al.*, 1987; Ashton, 1998; Chambers, 2005; Hosfield and Chambers, 2005). Artefacts from the terrace gravels tend to be stained with varying degrees of abrasion and rolling. Their condition might be due to several factors, but reworking from higher terrace sediments, or being carried downstream as part of the bed-load, are the most likely causes. In contrast, some artefacts are in fresh condition, usually with a white patination. The latter is often formed in subaerial conditions and associated with acidic soils (Stapert, 1976). The significance of these distinctions in artefact condition is underlined by clear technological differences in the Solent artefacts, with handaxes being predominantly rolled and stained, but Levallois artefacts being usually patinated and fresh. The different origin of the fresh material is also supported by the observations of Burkitt *et al.* (1939) at Warsash, who described fresh, patinated material as coming from fine-grained sediment overlying terrace gravels.

One further problem with the Solent area is the dominance of single assemblages or 'super-sites' in some tributary valleys. Biases in the record may have been created by the ease of collecting from large gravel quarries, which would have been compounded by other collectors being attracted to the pits. To help address this issue, more weight is given to patterns that emerge from a range of different sites with good samples of handaxes (e.g. >50), rather than reliance on large single sites (Table 4).

River Frome

The River Frome flows from above Dorchester into Poole Harbour, and is interpreted as following the course of the Upper Solent River (Fig. 1). There have been various complex interpretations of the terrace stratigraphy of the Frome between Dorchester and Wareham. They largely divide into the schemes developed by Mathers (1982b) and Allen and Gibbard (1993), who identified nine main terraces with relatively steep gradients, and the scheme based on Green (1946, 1947), but developed by Westaway *et al.* (2006) with subdivision of some of these terraces and with the assignment of shallower gradients. The difference between the interpretations of the gradients has implications for how these terraces correlate with those in the Bournemouth area and also for the timing of the breaching of the Chalk ridge between Purbeck and the Needles. The breaching led to the diversion of the Upper Solent into a new route to the west of the Isle of Wight. The scheme used here is that of Allen and Gibbard (1993).

The age of the terraces is unknown. Owing to the large number of handaxes and the absence of Levallois in the West Knighton Gravel (Table 1), Westaway *et al.* (2006) attributed the gravel to MIS 10. However, this interpretation is seriously challenged by the abundance of handaxes in various terraces elsewhere in the Solent and the paucity of Levallois in general. Therefore their interpretation of the dating is not followed here.

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Table 1 Numbers of handaxes and Levallois artefacts in the terrace gravels of the Solent River and its tributaries. Handaxe density km^{-2} of terrace area is also given for all rivers, except the River Frome, where there are insufficient data. The following mapping has been used: River Frome, Allen and Gibbard (1993); River Stour, Bristow *et al*. (1991) and Allen and Gibbard (1993); River Avon, Kubala (1980) and Clarke (1981); western Solent, Allen and Gibbard (1993); River Test, Edwards and Freshney (1987). For the Bournemouth area the Pennington Gravel equates with Terraces 1–7 of Bristow *et al*. (1991)

	Handaxes	Levallois	Terrace area (km^2)	Handaxe density		
Frome gravels						
Stoborough	0	0				
East Holme	1	0				
Worgret	3	0				
West Knighton	72	0				
Stokeford Heath	0	0				
Higher Hyde Heath	1	0				
Tonerspuddle Heath	1	0				
Bournemouth area						
'Pennington'	294	0	31.9	9.2		
Milford-on-Sea	83	2	4.4	18.9		
Stanswood Bay	32	0	2.2	14.5		
Taddiford Farm	853	21	13.6	62.7		
Old Milton	55	1	6.0	9.2		
Setley Plain	388	2	5.8	66.9		
Tiptoe	3	0	1.7	1.8		
Sway	12	0	3.9	3.1		
Lower Avon terraces					Upper Avon	Handaxes
T3	8	0	11.9	0.7	Low	11
T4	1	0	5.1	0.2		
T5	3	0	12.9	0.2		
T6	10	0	4.7	2.1	High	674
T7	416	0	8.7	47.7		
T8	8	0	9.3	0.9		
Western Solent terraces						
Pennington	0	0	6.0	0		
Lepe	2	0	6.4	0.3		
Milford-on-Sea	8	0	6.1	1.3		
Stanwood Bay	16	0	12.0	1.3		
Taddiford Farm	0	0	7.6	0		
Tom's Down	2	0	7.8	0.3		
Old Milton	219	2	24.8	8.8		
Mount Pleasant	1	0	19.3	0.1		
Setley Plain	5	0	29.1	0.2		
Test terraces						
T1	32	0	13.5	2.4		
T2	353	1	4.3	82.8		
T3	215	14	14.2	15.1		
T4	1577	8	11.0	142.8		
T5	13	0	4.2	3.1		
T6	152	0	13.3	11.4		
T7	5	0	3.2	1.6		
T8	11	0	2.3	4.8		
T9	1	0	1.3	0.8		
T10	1	0	1.3	0.8		
T11	2	0	0.6	3.6		

River Stour and Bournemouth area

There appears to be broader agreement in the mapping of the terraces in the Bournemouth area. Bristow *et al*. (1991) mapped 13 terraces (T1–T13), which broadly correspond to the named terraces of Allen and Gibbard (1993). Terrace 13 was split by them into the Tiptoe and Sway gravels and described by Westaway *et al*. (2006) as Terraces 13a and 13b. The mapping used here is that of Allen and Gibbard (1993), although (after Briant *et al*., 2006) using the western Solent terminology (e.g. Taddiford Farm Gravel for Ensbury Park Gravel; Fig. 2(a)). Some terraces in this area are attributable to the Solent rather than the Stour (e.g. the Old Milton Gravel to the south of the Setley Plain Gravel in Bournemouth). However, the Solent terraces within the Bournemouth area have been included within the Bournemouth analysis as they have been mapped as equivalent aggradational units to those of the Stour.

As with the Frome, there are few constraints on the age of the terraces. Westaway *et al*. (2006) argued that Levallois was introduced during the formation of the Taddiford Farm Gravel and therefore they dated this terrace to MIS 9–8. However, Levallois is also recorded from areas mapped as Old Milton and Setley Plain gravels, so any dating of this type requires more detailed scrutiny (Table 1).

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Table 2 Handaxe densities for terrace units in the Solent and tributaries, shown by percentage. Correlation of the Bournemouth area, western Solent and Avon is based on Kubala (1980) and Allen and Gibbard (1993). OSL dates are from deposits in the western Solent sampled by Briant *et al.* (2006). Correlation with the Test terraces is less certain. The correlation suggested here is based on the Stanswood Bay, Tom's Down and Mount Pleasant Gravels being equivalent to those of Test Terraces 2, 3 and 4 respectively (see text)

B'mouth/western Solent gravels	B'mouth % handaxe density	OSL (from Briant *et al.*, 2006)	Western Solent % handaxe density	Avon terraces	Avon % handaxe density		Test terraces	Test % handaxe density
Pennington	5.3	MIS 6–3	0	T1–T4	1.7			
Lepe		MIS 7b–3	2.6					
Milford-on-Sea	10.8		10.6	T5	0.4		T1	0.9
Stanswood Bay	8.3	MIS 8	10.9				T2	30.8
Taddiford Farm	35.8		0	T6	4.1	?		
Tom's Down			2.1				T3	5.6
Old Milton	5.2		**72.0**	T7	**92.1**			
Mount Pleasant			0.4				T4	**53.1**
Setley Plain	**38.2**		1.4	T8	1.7	?	T5	1.2
Tiptoe	1.0		0				T6	4.2
Sway	1.8		0				T7	0.6
							T8	1.8
							T9	0.3
							T10	0.3
							T11	1.3

Underlined entries denote the first reliable occurrence of handaxes within terrace gravels; entries in bold mark the peaks in handaxe density.

River Avon

There is less agreement about the terrace stratigraphy along the Avon. The river naturally divides into the Upper Avon (upstream of Downton, near Salisbury), and the Lower Avon. In the Upper Avon terraces are mapped as either Higher or Lower. The vast majority of sites and artefacts come from the Higher Terrace. Unfortunately it is difficult to relate these terraces to the Lower Avon, where a more complex sequence has been identified (Table 1).

The most widely used scheme for the Lower Avon is that of Kubala (1980) and Clarke (1981), who recognised 10 terrace gravels (T1–T10) and five older river gravels ('Higher Terrace Gravels') on the New Forest plateau (Fig. 2(c)). This scheme was expanded by Bristow *et al.* (1991), who subdivided the 10 terrace gravels into 14. Allen and Gibbard (1993) largely followed this scheme, but also considered in more detail how these terraces correlate with the main Solent terraces in the lower reaches of the Avon. A different scheme (C8–C16) was produced by Westaway *et al.* (2006) with shallower gradients, but it is not clear what archaeology occurs in each terrace. Therefore, the scheme followed here is that of Kubala (1980) and Clarke (1981), which is also the scheme used in the SRPP (Fig. 2(c)).

There are few constraints on the dating of the terraces, other than a ^{14}C date of 41 ka on peat (Barber and Brown, 1987) at Ibsley beneath Terrace 3 of Kubala (1980). Westaway *et al.* (2006) again used the absence of Levallois in handaxe-rich gravels for dating, even though they listed only one Levallois artefact from the whole of the Avon catchment (Table 1). This piece actually comes from one of the two principal sites: St Catherine's Hill, which is mapped as Terrace 8 (Kubala, 1980) or Setley Plain Gravel (Allen and Gibbard, 1993). The latter regarded this deposit as upstream of the Stour–Avon confluence and part of the Stour system. This interpretation is followed here.

Western Solent in the New Forest area

The terraces of the Solent in the New Forest area were first mapped in detail by Mathers (1982a), who recognised 10 numbered terraces. The area was remapped by Allen and Gibbard (1993), producing a new scheme with 14 named terraces (Fig. 2(b)). The latter's different correlations between gravels in the east and west of the area created steeper gradients than those of Mathers (1982a) for the terrace units. Finally, Westaway *et al.* (2006) reverted to the shallower terrace gradients of Mathers, but also added additional terraces to the scheme with new names. However, due to the paucity and poor provenancing of the artefacts the different mapping schemes have little impact on the archaeological interpretation. Therefore the scheme of Allen and Gibbard (1993) is used in this paper (Fig. 2(b)).

There are better dating constraints in this area than other parts of the Solent system. Organic beds attributed to MIS 5e have been found within the Pennington Gravel of Allen and Gibbard (1993). At Stone Point organic deposits have also been recorded, but occurring within the Lepe Gravel of Allen and Gibbard (1993). Although these organic beds were originally attributed to MIS 5e (West and Sparks, 1960), it has been suggested that owing to their higher altitude ($\sim$3–4 m higher) they might date to MIS 7 (Allen *et al.*, 1996). Westaway *et al.* (2006) renamed both the Pennington Gravel and the Lepe Gravel as the St Leonard's Farm Gravel and attribute both the organic deposits to different stages of MIS 5e. This interpretation has been supported by OSL dates on the gravels (Briant *et al.*, 2006, 2009a).

Briant *et al.* (2006) undertook further OSL dating at other sites in the western Solent, but the only consistent dates were from the Stanswood Bay Gravel, which they attributed to MIS 8. Dates on the attitudinally higher Tom's Down Gravel and Old Milton Gravel showed considerable variation, and were initially not regarded as reliable by the authors. However, recently attribution to MIS 8–9 and MIS 9–11 respectively has been suggested for these two gravels (Briant and Schwenninger, 2009; Briant *et al.*, 2009c).

Test Valley

The most detailed work in the Test Valley was undertaken by Edwards and Freshney (1987), who mapped 11 numbered

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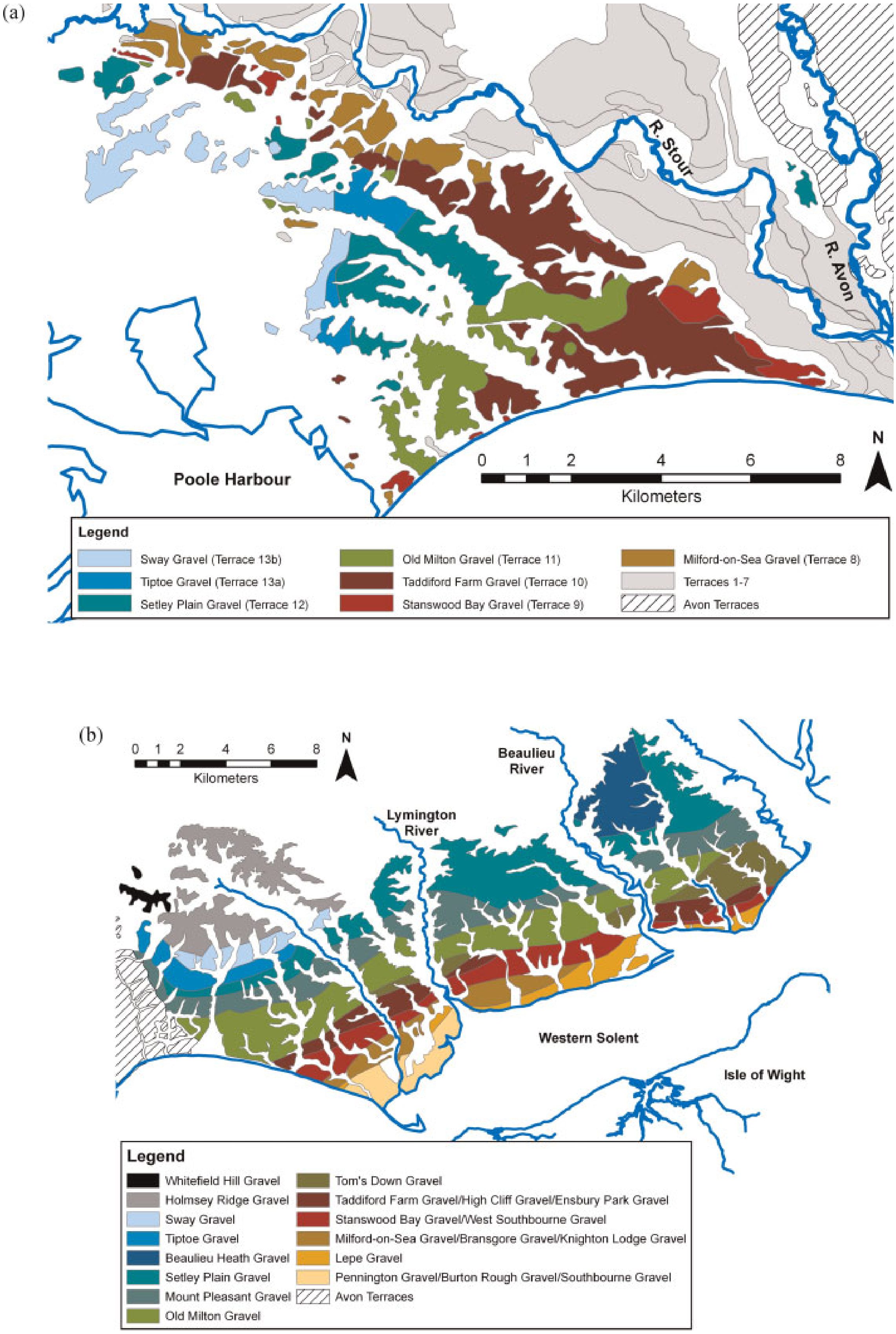

Figure 2 Maps of the Solent and tributaries showing distribution of terrace deposits. (a) Bournemouth area terrace deposits (Solent River and Stour), after Allen and Gibbard (1993) and Wessex Archaeology (1993). (b). Western Solent terrace deposits, after Allen and Gibbard (1993) and Wessex Archaeology (1993). (c) Avon Valley terrace deposits, after Kubala (1980) and Wessex Archaeology (1993) (d) Test and Itchen Valley terrace deposits, after Edwards and Freshney (1987) and Wessex Archaeology (1993). Figure locations in Solent region indicated in Fig. 1. The terrace extent data are derived from the Southern Rivers Palaeolithic Project mapping (Wessex Archaeology, 1993)

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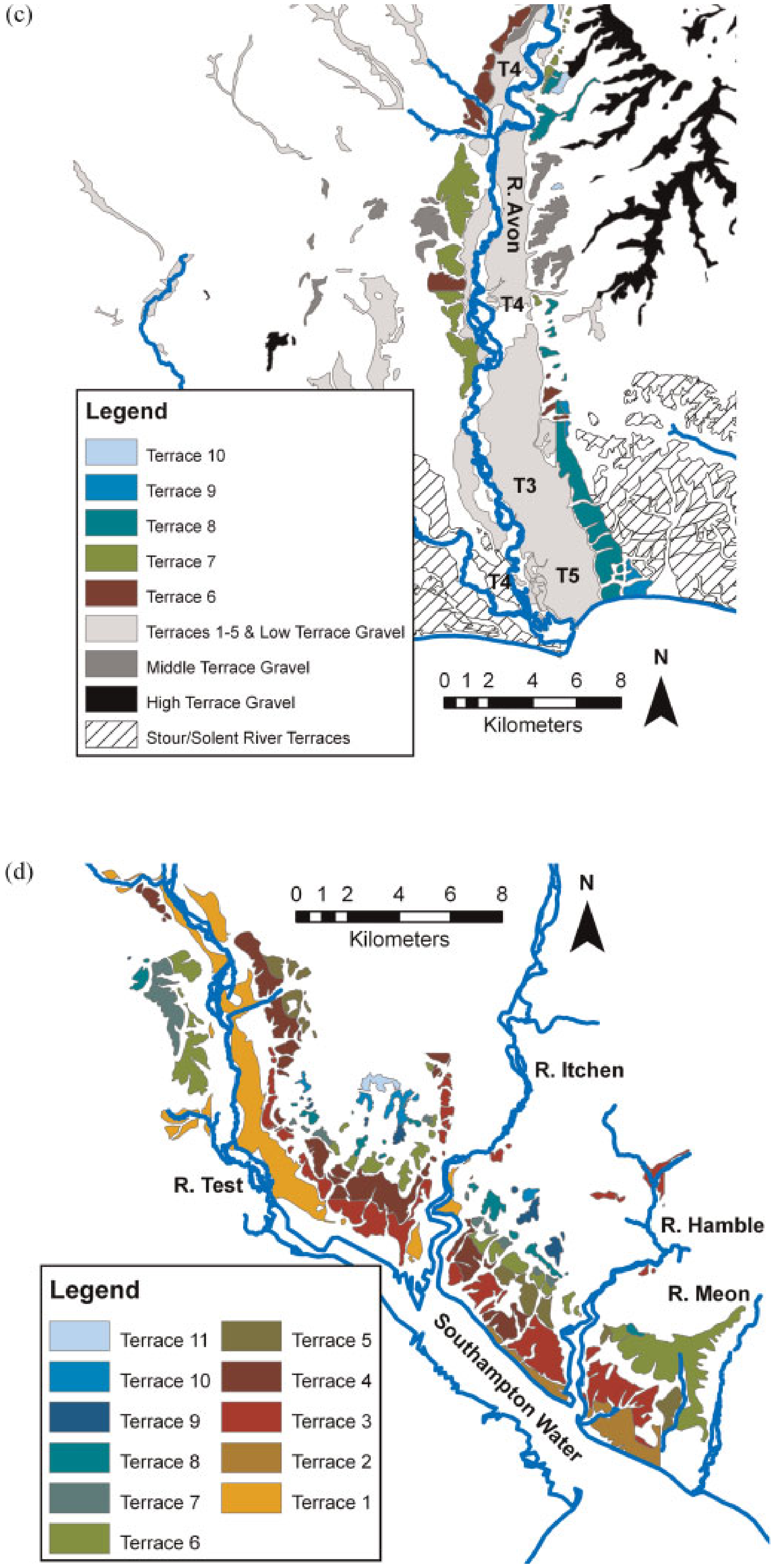

Figure 2 (Continued)

terraces (Fig. 2(d)). This scheme was modified by Westaway *et al.* (2006), giving the terraces new names, the most significant adjustment being to the terraces at Warsash. These had previously been mapped as predominantly Terrace 3, but also with areas of Terrace 2. Westaway *et al.* argued that Terrace 3 equated upstream to Terrace 4, based on terrace projections. Unfortunately, the projection they showed in their Fig. 17 put the terrace deposits at Warsash some 10 m too high (i.e. at ~25 m OD). Ground surface heights in this area only attain 15 m OD, which therefore casts serious doubt on their

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reinterpretation. As a result, the mapping of Edwards and Freshney (1987), as used in SRPP, is also adopted for this paper (Fig. 2d).

As with most other areas, there are few dating constraints on the terraces. Westaway *et al*. (2006) used Levallois material from Warsash as a means of dating. It is clear from the description of Burkitt *et al*. (1939) and the condition of the artefacts that the Levallois material comes from above the terrace deposits. Westaway *et al*. therefore suggested that Terrace 4 (mapped by Edwards and Freshney as Terrace 3 around Warsash) dated to MIS 10. Unfortunately there is currently no other dating evidence.

The early Palaeolithic record of the Solent

The artefact record and handaxe density figures for the different tributary and main Solent River channel areas are shown in Table 1 and a tentative correlation between the areas is suggested in Table 2. This is partly based on Allen and Gibbard's (1993) correlation between the Avon Terrace 6 (their High Cliff Gravel) and the Taddiford Farm Gravel. Further correlations can be suggested between the western Solent and the Test by comparison of terrace heights immediately upstream of their confluence. The Test terraces near Warsash are only 5 km to the east of the western Solent terraces near Fawley, on opposite sides of Southampton Water (Fig. 2(b) and (d)). Given the similar topography and terrace gradients, both areas should have comparable terrace heights. This suggests that the Stanswood Bay and Tom's Down gravels of the western Solent are equivalent to Terraces 2 and 3 of the Test respectively. Logically it would be thought that the Old Milton Gravel (being the next terrace up) would be equivalent to Terrace 4, but the latter has heights that equate better with the Mount Pleasant Gravel. Although the dating of these terraces is largely unknown, there are reliable OSL dates on the Stanswood Bay Gravel, suggesting attribution to MIS 8. The suggested dating by Westaway *et al*. (2006) is given for comparison as supporting information: Table 3. The results of the current artefact analysis are presented below.

Earliest appearance

The first arrival of humans in the Solent Basin can be assessed from the earliest artefact records from the different study areas. In all areas small numbers of artefacts have been found one or usually two terraces higher than those with peak artefact densities (Tables 1 and 2). However, in many cases it is not known whether the artefacts were surface finds or found within the terrace gravels. For the River Frome, a single handaxe was found in an area mapped as Tonnerspuddle Heath Gravel and possibly one from the Higher Hyde Heath Gravel, but in neither case can the artefacts be securely attributed to the terrace gravels.

In the Bournemouth area three handaxes were found associated with the Tiptoe Gravel, with one marked as 'base of gravel', and another marked as 'Wills Pit'. A strong contender for early archaeology is the under-studied group of 12 handaxes from Foxholes, an area of 19th- and early 20th-century pits dug into the Sway Gravel.

Six handaxes have been found in areas mapped as Terrace 8 of the Avon. Five of these pieces are described by Crawford *et al*. (1922) as coming from gravel pits at 200 ft at Rockford Common, Crow Hill and Hightown Hill, all near Ringwood. At least one of the artefacts from Rockford Common is described as being recovered in loose, uncemented gravel, 6–10 ft below

Table 3 Levallois artefacts from the Bournemouth area and the Test valley. Condition of those examined is given

Site	Levallois artefacts	Gravel/terrace	Condition type			
Bournemouth area			1	2	3	4
Brixey and Goods Pit, East Howe	2	Milford-on-Sea		1	1	
Council's Pit, West Howe	3	Taddiford Farm	2	1		
Kinson Cemetery, Bournemouth	Min. 2	Taddiford Farm				
Moordown, Bournemouth	1	Taddiford Farm				
King's Park, Bournemouth	7	Taddiford Farm				
Queen's Park, Bournemouth	2	Taddiford Farm				
Winton Farm, Bournemouth	1	Taddiford Farm			1	
Winton, Bournemouth	2	Taddiford Farm			2	
Fisherman's Walk, Bournemouth	3	Taddiford Farm				
Huntley Road, Bournemouth	1	Old Milton	1			
St Catherine's Hill, Christchurch	1	Setley Plain				
Railway Ballast Pit, Corfe Mullen	1	Setley Plain				
Corfe Mullen	1			1		
Queen's Park Avenue, Bournemouth	2			2		
Test gravels						
Lee-on-the-Solent	1	Terrace 2		1		
Warsash	19	Terrace 2 or 3	1	18		
Warsash, Fleet End	1	Terrace 3		1		
Colden Common	1	Terrace 3			1	
Ashfield	1	Terrace 4				
Highfield, Brickfield near Church	1	Terrace 4				
Chivers Gravel Pit, Romsey Extra	2	Terrace 4		2		
Belbin's Pit, Romsey Extra	3	Terrace 4		2	1	
Dunbridge Hill	3	Terrace 4				

1, fresh; 2, slightly rolled; 3, rolled; 4, very rolled.

Table 4 'Super-sites' in the Solent catchment showing the nature of the site and the relationship to bedrock. The significance of those sites is given in terms of the percentage of handaxes that each contributes to their terrace and to each area as a whole

River	Location	Gravel/terrace	Site	Bedrock	Handaxes	% terrace handaxes	% area handaxes
Frome	Moreton	West Knighton	Gravel pits	Chalk/Tertiary	70	97.2	90.0
Western Solent	Barton Cliff	Old Milton	Coastal cliff	Tertiary	197	90.0	77.9
Test	Dunbridge	T4 (Test)	Gravel pits	Chalk/Tertiary	953	60.4	34.9
B'mouth	Corfe Mullen	Setley Plain	Gravel Pits	Chalk/Tertiary	289	74.5	16.8
B'mouth	King's Park	Taddiford Farm	Gravel Pits	Tertiary	300	35.2	17.5
Avon	Wood Green	T7 (Avon)	Gravel Pits	Chalk/Tertiary	409	98.3	90.1

the surface. They are all rolled and stained, and there seems little doubt that some, if not all, of these handaxes come from within the terrace gravel.

The western Solent has produced handaxes on Setley Plain to the south of Brockenhurst, from pits which cut into sediments mapped as Setley Plain Gravel. One of these is illustrated in Crawford *et al*. (1922) and described as coming from terrace gravels. These authors suggest that handaxes were frequently found in these gravels, but only one piece survives. Further handaxes were noted by these authors to be found in pits 1 km to the south near Bottramsley in deposits again mapped as Setley Plain Gravel. Bury (1923) described and illustrated three further implements (and suggested the existence of others) from the Setley Plain locality, recovered from a pit at ~8–10 ft below the surface (itself estimated at ~140 ft OD). It again seems reasonable to argue that these handaxes came from the body of the gravel, and it is notable that Bury highlighted the absence of artefacts from between 150 and 300 ft OD (although he also mentioned the paucity of open pits at these higher elevations).

Finally, in the Test Valley, although the highest density of archaeology occurs in Terrace 4, there are instances of handaxes found in deposits as high as Terrace 11. There are two handaxes listed for Terrace 11, but there is no detailed location or contextual information. The same applies to one handaxe associated with Terrace 10. A handaxe associated with Terrace 9 is listed as coming from the White Rail Pit on Netley Common. This might be a candidate for archaeology within terrace gravel. Eleven handaxes are listed as coming from Midanbury Hill in Southampton, which is mapped as Terrace 8, but with no details on context. The same applies to the five handaxes from Stanbridge (near Romsey) associated with Terrace 7. The context is far more certain for the important assemblages from Pauncefoot Hill Gravel Pit and the Ridge Gravel Pit near Romsey Extra, which have been dug into the Terrace 6 gravels. The Ridge Gravel Pit has produced about 120 handaxes, all collected since the 1990s. Therefore, other than a possible handaxe in Terrace 9, the earliest certain occurrence of handaxes in fluvial gravels is in Terrace 6.

The first appearance data therefore suggest that handaxes probably first occurred in the Sway Gravel in the Bournemouth area, Terrace 8 of the Avon, the Setley Plain Gravel of the western Solent and Terrace 6 of the Test. If the correlations in Table 2 are broadly correct, then the earliest handaxes occurred in sediments at least as old as MIS 13.

Levallois

The occurrence of Levallois artefacts can potentially be studied from the Solent Basin to ascertain the arrival of this technology in the region. By contrast, it was used by Westaway *et al*. (2006) as a tie-point to help date the terraces in the basin. As they correctly state, the first evidence of 'proto-Levallois' in Britain seems to date towards the end of MIS 9 or early MIS 8 at Botany Pit, Purfleet (White and Ashton, 2003). It occurs more routinely in the Thames valley during late MIS 8 and MIS 7 at sites such as Ebbsfleet, the Lion Pit Tramway Cutting (Thurrock) and probably Crayford as part of the deposits ascribed to the Taplow–Mucking Formation (Bridgland, 1994; White *et al*., 2006). It also seems to occur widely in fresh condition on the surface of the Lynch Hill Gravel in west London at sites such as Creffield Road (Acton) and in the West Drayton and Yiewsley areas (Ashton *et al*., 2003; White *et al*., 2006). There are no clear records of it occurring within the Lynch Hill Gravel, from which large quantities of rolled handaxes have been recovered.

Elsewhere in Britain the occurrence of Levallois is rare and usually poorly dated, with the exception of Pontnewydd Cave (north Wales), where it occurs with handaxes and probably dates to a cooler phase in MIS 7 (Green, 1984; Aldhouse-Green, 1995). In contrast, there are sites in southwest England (Harnham and Broom) that have yielded assemblages containing handaxes, apparently without Levallois, which seem to be comparatively late in date. Harnham has recently been dated by biostratigraphy and amino acids to late MIS 8/early MIS 7 and has no evidence of Levallois (Whittaker *et al*., 2004). Meanwhile, the sediments at Broom have been dated by OSL, suggesting occupation during MIS 9 and MIS 8 (Toms *et al*., 2005; Hosfield and Chambers, 2009). Although three Levallois artefacts are noted by Roe (1968) and repeated in later publications (e.g. Wessex Archaeology, 1993), recent studies of the principal collections at the British Museum (Marshall, 2001), Exeter's Royal Albert Memorial Museum and Art Gallery, and Dorset County Museum (Hosfield and Chambers, 2009) have failed to identify them.

In the Solent area 71 Levallois artefacts are recorded, but some of these have not been examined since Roe (1968). In the current study 45 have been examined, but at least four of these are not Levallois, reducing the total figure to no more than 67. In distribution, none are recorded from the Frome and Avon valleys, and only two from Barton Cliff in the western Solent, with 29 and 36 Levallois artefacts associated with terraces from the Bournemouth area and Test Valley respectively.

For the Bournemouth area, 12 of the 29 pieces can be confirmed as Levallois, while it has not been possible to examine the remaining 17 pieces. If these have been correctly identified, then the vast majority (21) are associated with the Taddiford Farm Gravel, six with other terraces, and two with non-terrace areas (Table 3). Although a potentially early date for Levallois might be suggested by one possible core apparently associated with the Setley Plain Gravel, there are no contextual details (Kevin Dearling, pers. comm.).

Of the 12 Levallois pieces examined, only two have a recorded context. A slightly abraded Levallois flake comes from

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the Corfe Mullen area, but the context, other than 'Stour Gravels', is unclear. A further rolled Levallois flake comes from 'near [the] top' of the Brixey and Goods Pit in East Howe (mapped as Milford-on-Sea Gravel) and a further fresh Levallois flake was recovered 'from loam' in Huntley Road, Bournemouth (mapped as Old Milton Gravel). A further six Levallois pieces are also in fresh or slightly abraded condition, and rather different from the condition of the associated handaxes. This might suggest that these pieces come from sediments overlying the terrace gravels. However, there are also four examples which are in a rolled condition, of which three are associated with the Taddiford Farm Gravel and one with the Milford-on-Sea Gravel. Their condition might suggest that Levallois technology is introduced during the aggradation of the Taddiford Farm Gravel.

Of the 36 Levallois pieces recorded from the Test Valley, 24 come from the pits at Warsash. Although in SRPP 13 of these are attributed to the Fleet End Pits on Terrace 3, only one of these has been located in the current study. The remainder might be included in the 19 Levallois pieces from the general Warsash area, which covers both Terraces 2 and 3. The Warsash artefacts were described by Burkitt *et al*. (1939) and it is clear from their description of Park's Pit that at least some were found from just below a blue clay and were not part of, but located above, the terrace gravels. Unfortunately Park's Pit has not been relocated since Burkitt *et al*. (1939). The context of the Levallois artefacts is further supported by their condition. Together they form a coherent group being slightly abraded with creamy patination, and are very different in condition to the rolled, iron-stained handaxes from this area.

There are a further 12 Levallois artefacts from elsewhere in the Test Valley. Of the five (out of six) examined from Belbin's and Chivers pits, north of Romsey, all but one are in a slightly abraded, patinated condition, in marked contrast to the handaxe material from the same sites. Again, they probably come from sediments overlying the Terrace 4 gravels. Other artefacts associated with Terrace 4 gravels (at Ashfield, Highfield and Dunbridge) have not been located. Of the remaining two artefacts, one is a Levallois point in fresh condition from Lee-on-Solent, an area mapped as Terrace 2, while the other is a rolled, stained flake from Colden Common, which is mapped as Terrace 3.

In summary, there are no clearly documented examples of Levallois material actually being found within terrace gravels. However, if the rolled and stained condition of artefacts is used as a criterion for placing them within terrace gravels, then it might suggest that Levallois was present within the Taddiford Farm Gravel in the Bournemouth area and, with even less certainty, within Terraces 3 and 4 in the Test Valley. Given the uncertainty of context, the tiny database and the likely interpretation that the majority of Levallois artefacts come from overlying sediments, it is clear that the presence of Levallois in the Solent area cannot be used reliably as a means of dating the terraces, particularly in the southwest region, where the timing of its introduction is uncertain.

Patterns of change

The distribution of the handaxes in the different terraces can potentially be used to study changes in human activity over time. Unfortunately for some tributary areas the handaxe counts are too small, or are too dominated by single assemblages to provide meaningful results. Major sites dominate the otherwise very low artefact counts from the River Frome and River Avon. For the Frome virtually all the artefacts come from the Moreton Gravel pits, mapped as West Knighton Gravel. In the case of the Avon, the record is dominated by the prolific site of Wood Green, mapped as Terrace 7. This is mirrored by the results from the Upper Avon, in particular from Salisbury, where the vast majority of artefacts come from the Higher Terrace.

For the western Solent's 255 handaxes, 200 are marked as coming from the beach and cliffs at Barton-on-Sea (Old Milton Gravel). However, Evans (1897) implied that some of these artefacts may also have come from coastal exposures between Chewton Bunny and Milford-on-Sea, an area that also covers Taddiford Farm, Stanswood Bay and Milford-on-Sea gravels. Inland there has been comparatively little quarrying and little urban development, which probably explains the paucity of artefacts in these areas. If the Barton-on-Sea assemblage is removed from the analysis due to the uncertain provenance, the number of artefacts is too low to provide significant results.

Although there are difficulties with the records from the Frome, Avon and western Solent due to provenance and the domination of single sites, it is still notable that the marked peaks all occur within the earlier, rather than later terraces. For the Frome the peak is in the West Knighton Gravel, for the Avon Terrace 7 and the Higher Terrace upstream, and for the western Solent probably the Old Milton Gravel. If the correlations in Table 2 are correct, then peak densities for the Avon and western Solent are at least two terraces higher than the Stanswood Bay Gravel and therefore a conservative estimate would place these peaks in MIS 10 or older.

The Test Valley and the Bournemouth area have produced much larger artefact assemblages, and although there are some very large sites, they come from a range of different terraces, and are complemented by significant quantities of artefacts from other locations. The history of quarrying and urban development has also meant that there have been opportunities for collection from a range of different terraces. The artefact density results for the Bournemouth area appear to show a clear pattern, with a peak density in the Setley Plain Gravel and a high density in the Taddiford Farm Gravel. However, one anomaly is the low artefact density in the Old Milton Gravel. This is particularly curious given the apparent abundance of handaxes in this same gravel on the other side of Christchurch Bay in the western Solent area.

A further problem with the pattern from the Bournemouth area is the peak density within the Setley Plain Gravel, which is caused by the prolific sites at Corfe Mullen. If these sites are removed from the analysis, then the artefact density for the Setley Plain Gravel is reduced to $\sim$17 handaxes km^{-2}, making it a far less significant peak. If the large assemblage from King's Park is also removed, this reduces the artefact density from the Taddiford Farm Gravel to $\sim$40 handaxes km^{-2}. Despite the data adjustments these two terraces still retain high peaks, however. If the correlations in Table 2 are correct, then the Taddiford Farm Gravel probably dates to MIS 9 or 10, and the Setley Plain Gravel to MIS 12 or earlier.

The Test Valley data reveal a clear peak in Terrace 4, and a relatively high density in Terrace 2. This is partly accounted for by the prolific assemblages from Dunbridge and by those from Hill Head respectively. But even if these assemblages are removed from the analysis, Terrace 4 still has higher artefact densities than the other terraces, with over 40 handaxes km^{-2}. The correlation in Table 2 would suggest that the peak in artefact density is attributable to MIS 12 or earlier.

There is a general pattern in all the study areas of artefact density peaks occurring in higher rather than lower terraces. A conservative interpretation of the evidence, based on OSL dates and relative terrace position, would suggest that most peak densities occur in sediments dated to MIS 10 or earlier.

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Table 5 Handaxe density data for terraces gravels in the Bournemouth region

Gravel	Terrace area (km^2)	Handaxes	Density/terrace	Urban area (km^2)[a]	Density/urban terrace	Quarry area (km^2)[b]	Density/quarry area
Milford-on-Sea	4.36	83	19.0	0.35	1029	0.02	24 147
Stanswood Bay	2.15	32	14.9	1.30	53	0.06	1 167
Taddiford Farm	13.59	853	62.8	10.07	1151	0.10	118 288
Old Milton	5.99	55	9.2	4.72	70	0.05	6 212
Setley Plain	5.78	388	67.2	1.90	1180	0.09	25 189
Tiptoe	1.72	3	1.7	0.65	8	0.06	86
Sway	3.90	12	3.1	0.81	58	0.23	207

[a] Urban extents derived from 3rd revision 1:10 560 mapping.
[b] Quarry extents derived from 1st edition, and 1st, 2nd and 3rd revisions ('overlapping' quarry extents from different editions/revisions therefore represent sites with extended working lives).

'Super-sites'

'Super-sites' are defined as assemblages that contribute more than 10% of the total handaxes from an individual study area. The dominance of such sites potentially biases the archaeological record by reflecting collection opportunities rather than patterns of artefact distribution. The amount of bias that the 'super-sites' are possibly creating can be shown through the percentage of handaxes that each site contributes to the individual terrace, and to the area as a whole (Table 4). This problem has been partially dealt with by treating with caution some of the data presented from the Frome, Avon and western

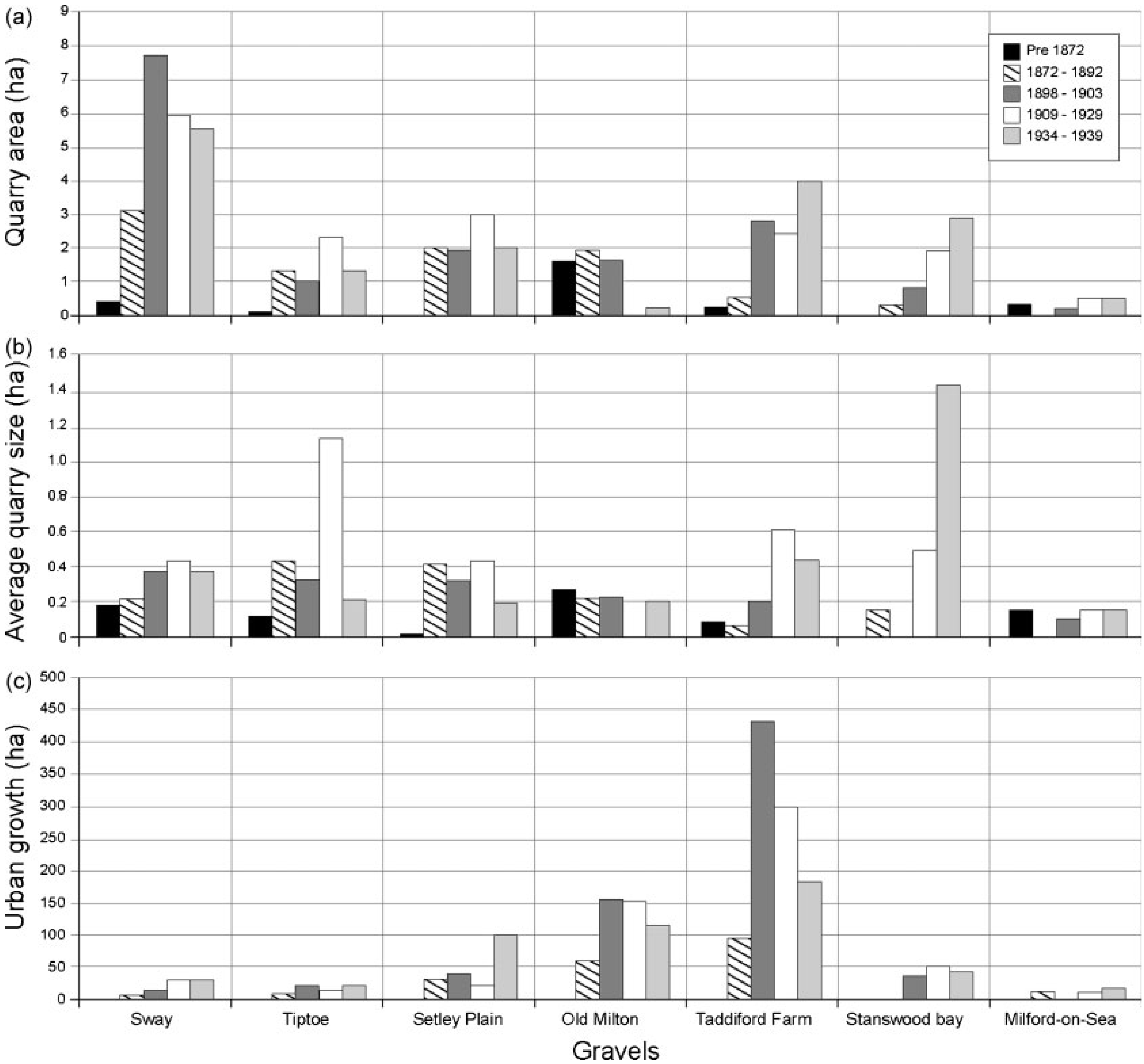

Figure 3 Changes in quarrying and urbanisation in the Bournemouth area between 1872 and 1939. (a) Terrace area (ha) affected by sand and gravel quarrying. (b) Average size of quarries (ha) on each terrace. (c) Terrace area (ha) affected by urbanisation

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Solent. It has also been shown how Corfe Mullen and King's Park dominate the Bournemouth area, and Dunbridge the Test Valley, although removal of these sites from the analysis still leaves the peak densities in those same terraces. A more detailed analysis is shown in supporting information: Table 4.

It is also worth investigating the nature of the 'super-sites' and where they occur in the landscape, which is often just downstream of the Chalk/Tertiary bedrock boundaries (Fig. 1 and Table 4). The explanation for this phenomenon is in part due to an abundance of fluvial gravels at and below this juncture. The abundance can be explained by the steeper gradients of the rivers through the Chalk, with steeper-sided valleys and with few terrace gravels surviving in these areas. The consequence was the offloading of the gravel once the rivers reached the Tertiary bedrock, where there were shallower river gradients. On the Tertiary bedrock the rivers appear to have migrated laterally, which allowed for the preservation of the terrace deposits discussed above (cf. Bridgland, 1985; Allen and Gibbard, 1993).

The rich gravels in these Chalk/Tertiary boundary areas would have created good raw material sources for early humans, which partly explains the existence of large assemblages in these areas. In addition, the gravels probably contain a large reworked element from earlier terraces in the Downland valleys, as suggested by Hosfield (2001) for the heavily reworked artefacts in the Dunbridge (River Test) and Wood Green (River Avon) assemblages. Finally, the gravels were a rich resource for modern aggregate companies, which in the late 19th and early 20th centuries exposed these gravels to handaxe hunters and the consequent proliferation of large collections.

The effect of biases in collecting for the Bournemouth area is dealt with in more detail below, and for the Test Valley it does not appear to have a major effect on the figures. However, there are a few observations that can be made for other areas. Other than the Moreton Pits, collecting opportunities in the Frome Valley were extremely limited. For the western Solent, Barton Cliff provided the easiest opportunities being adjacent to the large resort of Barton-on-Sea, and although the figures for this site may include other locations along the coast (Evans, 1897) these were along less accessible, less populated parts of the coast. More can be said about the Avon Valley, where the collections are dominated by Wood Green. In fact this was a comparatively small quarry in Terrace 7, but yielded over 400 handaxes despite much more extensive quarrying into Terraces 3, 4, 7 and 8 to the south between Fordingbridge and Ringwood. Study of the history of Wood Green has suggested that the large assemblage from this pit was due to the activities of a local collector, Ernest Westlake, at the end of the 19th century (Hosfield, 1999). The historic mapping for the Avon valley immediately north of Ringwood shows that several sand and gravel pits (around Ibsley, Rockford and Poulner) were also active at this time. It is clear from Westlake's archive that he was aware of, and probably visited, some of these sites (Hosfield, 1999), which suggests that the large assemblage from Wood Green was not simply created by biases in collection.

The Bournemouth study area

The Bournemouth area is particularly rich in artefacts and has had a long collecting history. It lends itself to further investigation of some of the specific questions that have arisen from the discussions above. These include questions about how the development of gravel extraction and the timing of the urbanisation of Bournemouth have affected access to the different terrace deposits and the consequent collection of Palaeolithic artefacts. Where possible the data have been assessed in a similar way to the information presented in Ashton and Lewis (2002) for ease of comparison, although owing to the chronological uncertainties of the Solent terraces it has been necessary to assume that the durations of the different terraces are equivalent. The Bournemouth data can also be used to investigate the derivation of artefacts from upstream or from higher terrace gravels and the effect that this may have had on artefact densities.

Quarrying and urbanisation

For the Bournemouth area the collection of Palaeolithic artefacts was at its peak during the 1920s and 1930s, as is evident from the assemblages from King's Park, Corfe Mullen and Moordown (e.g. Bury, 1923, 1933; Green, 1946; Calkin and Green, 1949). Therefore understanding the development of quarrying and urbanisation through this period is essential to understanding the archaeological record. Unfortunately, the mapping of quarries in SRPP (Wessex Archaeology, 1993) was selective and does not provide time interval data. Therefore gravel and sand quarry locations, extents and their approximate ages have been digitised from the UK's County Series 1:10 560 mapping (1st edition, and 1st, 2nd, and 3rd revisions).

The analysis shows that there was an increase from before 1872 to ca. 1900 in the number and average size of active quarries, and in the size of the largest quarries (supporting information: Fig. 1 and Table 5). However, small quarries ($<1000\,m^2$) were still present throughout the period. From ca. 1910 to 1940 there was a decrease in the number of quarries and a small reduction in the overall area covered by quarrying, but the trend towards larger individual extraction sites continued. The quarries were typically sited on the margins of urban Bournemouth, although smaller quarries in particular did occur within built-up areas.

The mapping also indicates important differences in the exposure of different terrace deposits through quarrying (Fig. 3(a)). The Sway Gravel was the most extensively quarried, with major activity after about 1900. Significant areas of Setley Plain, Taddiford Farm and Stanswood Bay gravels were also quarried after about 1870, 1900 and 1934 respectively. In contrast, any exposures of the Old Milton Gravel were minimal after about 1910. This may help to explain the low numbers of artefacts from this gravel as little was exposed during the peak of collecting in the 1920s and 1930s. The working of the Milford-on-Sea Gravel was limited in scale throughout the entire period.

The general trend towards fewer, larger quarries is also shown for the individual terraces, in most cases the size peaking between about 1910 and 1930 (Fig. 3(b); supporting information: Table 6), which may be important if larger, longer-running quarries were visited more regularly by collectors. Of particular note was the dramatic rise in average quarry size in the Stanswood Bay Gravel during the 1930s, reflecting the presence of a large extraction area southwest of Canford Magna. However, an exception was the Old Milton Gravel, where there were no active quarries during the 1920s and only one in the 1930s, during a key period of collection. The data also show that the number of quarries exploiting Setley Plain Gravel increased during the 1920s and 1930s, although the decline in average size during the 1930s might have discouraged collecting from these pits.

The changing urban extents of Bournemouth were also digitised from the 1:10 560 mapping. None of the six terraces were significantly urbanised by the time of the 1st edition

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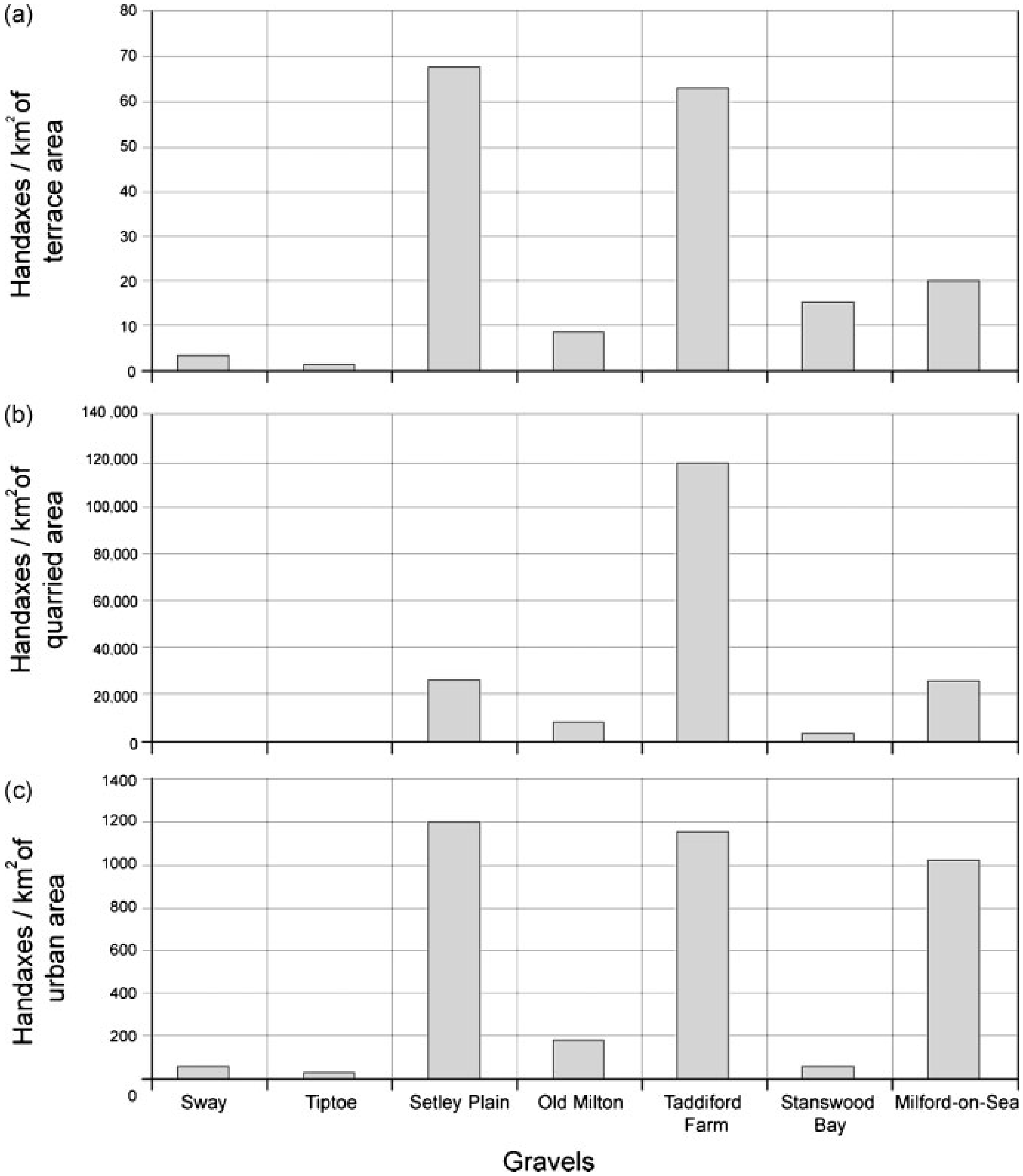

Figure 4 Handaxe density data for terraces in the Bournemouth area, calculated according to: (a) terrace area; (b) quarried terrace area; (c) urbanised terrace area

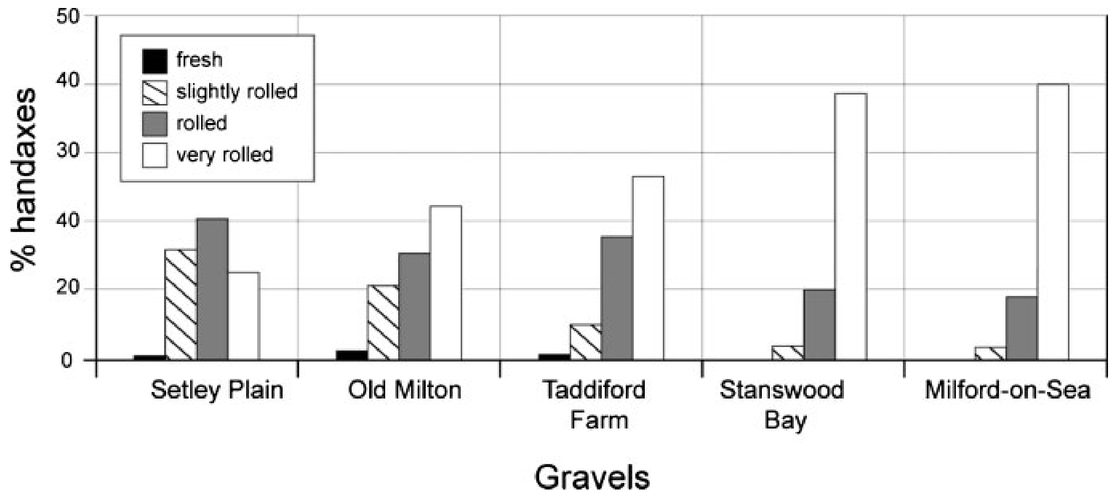

Figure 5 Degree of rolling of handaxes for each terrace in the Bournemouth area. Data based on British Museum collections (methodology after Ashton, 1998) and supplemented by data in Hosfield (1999; methodology after Shackley, 1974). Owing to differences in recording schemes the Hosfield data were recalibrated using a test sample from the Corfe Mullen pits

mapping and were therefore not exposed on a significant scale prior to the recognition of human prehistory and the significance of Palaeolithic artefacts. Major expansions occurred between all of the mapping editions/revisions, with urban areas growing by 308% (from ca. 1870 to 1890), 162% and 157% respectively. Unlike the quarries, urbanisation covers a significant proportion of the terrace deposits, and there are some notable differences between the terraces (Fig. 3(c)). In particular, there was considerably more urbanisation on the Taddiford Farm Gravel and significant development on the Old Milton Gravel, primarily occurring between 1900 and 1930. Again this period covers a key time for collecting.

Inclusion of the quarrying and urban extents data into an artefact density model for these terraces (after Ashton and Lewis, 2002) controls for the impact of differential terrace exposure and collection opportunities upon the artefact density patterns (Fig. 4 and Table 5). The Taddiford Farm Gravel maintains a rich artefact signal for all three measures, despite the extensive urbanisation over this terrace, while the weaker artefact signals for the Sway, Tiptoe, Old Milton and Stanswood Bay gravels would appear to be genuine, and not the products of limited exposure of those deposits.

The patterns for the Setley Plain and Milford-on-Sea gravels are more complex. The Setley Plain artefact densities are relatively high and comparable to the Taddiford Farm data when measured against deposit and urbanised deposit areas. However, the strength of the signal is greatly reduced by the quarry data, which highlights the proportionally extensive working of this deposit (e.g. at Corfe Mullen) and suggests that the numbers of artefacts from the Setley Plain Gravel are at least in part a product of better collection opportunities. The Milford-on-Sea artefact record is significantly boosted by the urbanisation data, which highlight the limited exposure of this deposit, while quarrying of this gravel was also small-scale.

Overall, the model suggests that the apparent artefact ‘spike’ in the Taddiford Farm Gravel is a genuine pattern, that the Setley Plain’s apparent richness may be somewhat over-represented, and that the Milford-on-Sea Gravel is potentially richer than it appears. However, these observations also need to be considered against the impact of artefact derivation upon the archaeological record.

The effect of handaxe derivation on the archaeological record

The secondary context of the archaeology within terrace gravels is a problem when considering them as a reflection of human activity and, potentially, population. The only certainty is that the artefacts cannot be younger than the gravel in which they are contained. With very few exceptions the artefacts in the Solent catchment as a whole, and specifically within the Bournemouth area, are clearly derived, being both rolled and abraded. The process of derivation is complex, but there are likely to be two major forms. Artefacts could have been transported downstream, making them broadly contemporary with the gravel bed-load. Alternatively, artefacts could have been reworked from higher terrace deposits, making them considerably older than the formation of the gravel in which they were found.

One method of trying to distinguish between the two types of derivation is to analyse the degree of abrasion and rolling within the different terrace units. If reworking from higher terrace units is a significant problem, then it would be expected that the proportion of rolled material would increase in lower terraces. If, on the other hand, the material was simply derived from upstream, there should be a similar range of rolled material within each terrace.

For this section a total of 669 handaxes (39% of the Bournemouth area collections) have been studied, with the degree to which each handaxe has been abraded and rolled noted on a scale of 1 to 4 (as defined in Ashton, 1998). The results for each terrace (Fig. 5) suggest that there is an increase in rolling and abrasion of handaxes through time from the Setley Plain Gravel to the Milford-on-Sea Gravel. This supports the idea that a significant number of handaxes were derived from higher terraces into lower terraces.

A different way of assessing the derivation of handaxes is through studying the terrace areas and assessing the likelihood of some gravels being reworked by the river into lower terraces. The gravels in the Bournemouth area are mainly attributable to the Stour, but in the southern part of the town are probably laid down by the Solent, with the confluence initially to the west and then through time shifting to the east of Bournemouth. This change in confluence location was created by the two rivers migrating laterally away from each other through time: the Stour towards the north and the Solent towards the south (Allen and Gibbard, 1993). The effect of this was to create an interfluve consisting of terrace remnants from both rivers surviving in the Bournemouth area. To the south the Solent terraces have been truncated by the current coastline, so that only the Taddiford Farm and higher gravels survive in significant quantities. To the north, the Stour terraces survive better with most of the higher terraces (Milford-on-Sea Gravel and higher) represented. One exception (with only a 0.23 km^2 area surviving) is the Old Milton Gravel, which would appear to have been almost entirely reworked by the river into the Taddiford Farm Gravel (Fig. 2(a)). If correct, then the Taddiford Farm Gravel would have a more enhanced handaxe density than would otherwise have been the case. Although it is difficult to measure this effect, it needs to be borne in mind when interpreting the data for changes in human activity and possibly population through time.

Discussion

Analysis of the lithic record from the Solent basin has highlighted significant problems with the interpretation of the data, but has also explored ways in which some of these difficulties might be overcome. In addition, there are several patterns in the data that relate to human behaviour within the area, which has highlighted possible differences with the records from other river basins in Britain.

The main problem of the Solent basin remains the different interpretations of the terrace mapping and how the different stratigraphies in the various study areas correlate with each other. Providing firm answers to this problem will only be achieved through new fieldwork and new dating programmes at key sites. What is also clear from the above analysis is the difficulty of using artefacts as a means of dating the different terraces (Westaway *et al.*, 2006). The main issues are the ongoing debates about the first introduction of new technologies, the frequent use of low sample sizes and the lack of scrutiny of the contexts of the artefact record. It is now clear that the very low occurrence of Levallois artefacts in the Solent basin means that they cannot be used reliably to date the terraces.

The frequent absence of contextual detail is a problem for any interpretation of the Solent record, although by more careful selection of sites some of these problems can be overcome. Further problems arise from the biases introduced

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into the artefact record from collection history and the disproportionate affect of 'super-sites'. However, the paper has explored ways of addressing these problems through a better understanding of the development of quarrying and urban growth and by examining the data without the 'super-sites'. The paper has also drawn attention to the difficulties of using the artefact records from the Frome, western Solent and possibly the Avon because of the low numbers of artefacts in many of the terraces; they can only be used reliably for presence and absence data. In contrast, the Bournemouth area and the Test Valley seem to have more robust records that can be used with greater confidence to reconstruct human occupation. These records are not without their difficulties, in particular the issue of reworking of artefacts from higher into lower terraces, which has been shown to be a problem in the Bournemouth area. Future modelling may unravel some of these difficulties.

Patterns in the Solent and Thames data

Despite all these problems, there are some patterns that can be discerned from careful scrutiny of the data. The first evidence of human appearance in the Solent basin is generally two terraces higher than the highest artefact densities. Handaxes probably occur in the Sway Gravel in the Bournemouth area, Terrace 8 of the Avon, the Setley Plain Gravel of the western Solent and Terrace 6 of the Test. Although at present there are no reliable dates for these terraces, potentially they contain evidence of some of the earliest archaeology in Britain. New dating work is needed on these sites.

Where the peaks in artefact density occur in the different study areas is open to more debate and only the Bournemouth area and the Test Valley can be used with any confidence. Despite the problems in these two areas, the analysis still suggests that the largest densities occur in the Setley Plain and Taddiford Farm gravels for the Bournemouth area, and in Terrace 4 gravel for the Test Valley. Overall, peak densities probably occurred between MIS 13 and MIS 10.

Some comparisons can be made with the data presented from the Middle Thames (Ashton and Lewis, 2002). Here it was argued that peak artefact densities occurred in MIS 11 and from then on declined, with no clear evidence for artefacts from late MIS 7 or early MIS 6 until late MIS 4. Although the Solent data are less clear, a similar pattern has been identified up to MIS 8, which lends some support to the data from the Middle Thames.

The human occupation of Britain

If artefacts can be used as a proxy for population during the early Palaeolithic, then these results pose questions about the controlling factors on human presence in Britain. Both the Thames and Solent regions indicate relatively larger populations during the latter part of the Lower Palaeolithic, ca. 500–350 ka. The suggestion that Middle Palaeolithic populations were increasingly adapted to the mammoth steppes of Eurasia, and only reached Britain when this biome expanded to the west (Ashton, 2002; Ashton and Lewis, 2002) unfortunately cannot be tested by the current Solent data, because of the paucity of palaeoenvironmental evidence.

The poor Levallois record from the Solent also makes it difficult to test directly the interpretation that the drop in artefact numbers in the Middle Palaeolithic reflects changes in the use and discard of Levallois technology, rather than population decline (Scott, 2006; White *et al.*, 2006). However, indirect evidence is provided by this lack of Levallois together with the overall MIS 8–7 record from southwest England, in particular the rich handaxe sites at Harnham and Broom. The Solent record stands in stark contrast to the large Levallois assemblages from the Thames Valley, with the exception of Warsash, which lies on the eastern side of the Solent Basin (Table 3 and Fig. 1). If handaxe technology dominated assemblages in southwest Britain during this period then similar discard patterns might be expected to those found in the Lower Palaeolithic. This could suggest that the drop in handaxe densities in the Solent is a genuine reflection of lower populations in the early Middle Palaeolithic. Unfortunately, too little is known about handaxe discard patterns in the early Middle Palaeolithic to support models of population decline in this period at the current time.

An alternative explanation for the decline in artefact numbers and possibly human population lies in the changing palaeogeography of Britain. New evidence suggests that the initial breach of the Weald–Artois anticline to create the Dover Strait occurred towards the end of MIS 12, but that there may have been a significant widening of the Strait towards the end of MIS 6 (Gibbard, 2007; Gupta *et al.*, 2007; Toucanne *et al.*, 2009). Although the initial formation of the Strait would have impeded access to Britain in the Channel region, colonisation from the east may have been easier due to the relatively high floor of the southern North Sea Basin. During MIS 11 the height of the floor must have been close to present-day sea level, as shown by the presence of the 'Rhenish fauna' at Swanscombe, Clacton and Tillingham (Kerney, 1971; Roe, 2001; Ashton *et al.*, 2008). However, the North Sea fills a subsiding basin which reaches depths of 40 m today (Busschers *et al.*, 2008). Entry to Britain across this area was therefore controlled by the progressive deepening of the basin and by climatically driven lowering of sea level. As a consequence colonisation became increasingly difficult during temperate episodes, so that by MIS 5e a major drop in sea level of perhaps 30 m would have been required to gain easy access from the east (Ashton *et al.*, 2009). These changes in geography provide a clear explanation for the decline in Middle Thames and Solent artefact numbers and arguably human population over time.

The changing palaeogeography of Britain might also explain the differences in the early Middle Palaeolithic artefact assemblages in the Thames and Solent rivers. Easterly routes into Britain, along the Thames or other eastern rivers, were dependent on the geography of the North Sea basin. Routes from the south along the Solent, however, were dependent on the width of the English Channel or in cooler episodes the Channel River. By MIS 8 and 7 a drop in sea level of about 20 m would have been needed to re-establish a land connection across the North Sea basin. By contrast, a drop of at least 30 m would be required in the Dover Strait and a drop of at least 60 m in the English Channel to significantly reduce the sea barriers in these areas. These depths are based on current topography, but due to uplift in the Channel region (estimated at between 30 and 40 m since MIS 11; Lagarde *et al.*, 2003) they actually underestimate past depths and the challenges to colonisation across this area. The contrasting geographies therefore might have led to colonisations during different climatic and environmental phases in the two regions. It is also likely that these colonisations emanated from different areas, with routes from the south leading into the Channel River and from there into the Solent, Seine and Somme, whereas eastern routes would have led from the Rhine and Meuse into the eastern rivers of England, such as the Thames.

Evidence for regional differences in early Middle Palaeolithic archaeological signatures is also now being identified on

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mainland northwestern Europe, with Levallois-dominated industries in northern France, Belgium and the Netherlands and assemblages with handaxes being found south of the Seine (Scott and Ashton, 2009). In combination, this evidence strongly supports the interpretation that the differences in the early Middle Palaeolithic assemblages between the Thames and the Solent are due to colonisation of distinct populations from different regions of northwestern Europe. Understanding of the changing palaeogeography of Britain therefore not only provides explanations for the drop in artefact numbers and possible population decline from the Lower into the Middle Palaeolithic, but also provides reasons for changes in technology in different regions through time.

Conclusions

The Solent Basin contains one of the major resources for understanding the Lower and Middle Palaeolithic of Britain, although there are still problems in the interpretation of the data. Many of these problems can be overcome through careful selection and modelling of that data, together with new fieldwork and dating programmes to understand the chronostratigraphy. Reassessment of the data does, however, broadly support the suggestion of peak populations in Britain during the period MIS 13 to MIS 10, with apparent falls in population from MIS 9. Better understanding of these data should also feed into interpretations of the complex palaeogeography of Britain and how this might affect different populations entering Britain from different areas of Europe.

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