CHAPTER 4

CASE STUDY INVESTIGATION OF THE BROOM LOWER PALAEOLITHIC ASSEMBLAGE

1. INTRODUCTION

Chapter 3 provided the geoarchaeological and geochronological context for a case study investigation of the Lower Palaeolithic secondary context assemblage from Broom. This resource offers an invaluable opportunity to test whether a palimpsest artefact assemblage can yield high resolution archaeological information with respect to; (1) the original geographical source(s) of stone tools recovered from a secondary, fluvial context; and (2) potential temporal patterning in the technological composition of the assemblage. The investigation of these issues is tenable for the Broom artefact assemblage thanks to the existence of C.E. Bean's detailed archive, including his field notebook and collection of site photographs. The Bean archive has been examined previously (Green 1988), but is re-investigated here with emphasis upon a more detailed technological examination of the artefacts and a new approach to the issue of artefact transportation within a fluvial environment.

This chapter is therefore concerned with an assessment of the relative homogeneity and/or heterogeneity of the Broom artefact assemblage, in terms of the spatial and temporal origins of the recorded artefacts. The Broom assemblage is compared against the Dunbridge assemblage (recovered from river terrace gravels in the valley of the River Test, Hampshire (Dale 1912a, 1918), both to test the transferability of the analytical methodologies and to explore the potential variability in spatio-temporal structure that may exist between different secondary context assemblages. Specifically, the analysis of the Broom artefact assessment explores:

- The technological characteristics of the artefacts within the assemblage.
- The stratigraphic origins of individual artefacts.
- The potential source(s) of the artefacts, prior to fluvial transportation, as indicated by abrasion, edge micro-flaking and morphological data.

2. THE BEAN ARCHIVE

The Bean archive was compiled by the late Charles Bean, F.S.A., Surveyor for Sherborne and a keen (and distinguished) amateur archaeologist. It documents 90 visits made by Bean to the site of Broom between September 1932 and October 1941, and his recovery of large numbers of Palaeolithic artefacts from the fluvial sediments of the River Axe that were exposed at the site. Bean's records documented the development of the working faces at Broom, the exposure of the sediments (also recorded in sixty site photographs), the artefacts (Section 2.3), and are a companion to the Bean collection of over 900 Palaeolithic stone tools (Green 1988: 173). One of the most valuable aspects of the Bean archive are the site plans and sections that he drew at intervals between 1935 and 1931, reproduced here as Figure 120–Figure 128.

2.1 Development of the Broom sites

In 1932, Pratt's Old Pit (lying to the north of Holditch Lane) extended approximately 75m from east to west, and 30m from north to south. The pit was worked on two, slightly uneven, levels, with a lower floor at *c.* 47.5m OD (in August 1933 the lowest point of the pit was described as lying approximately 8 feet below the road level at the cottages (*c.* 49m OD) and an upper floor approximately 1.5m above. At the

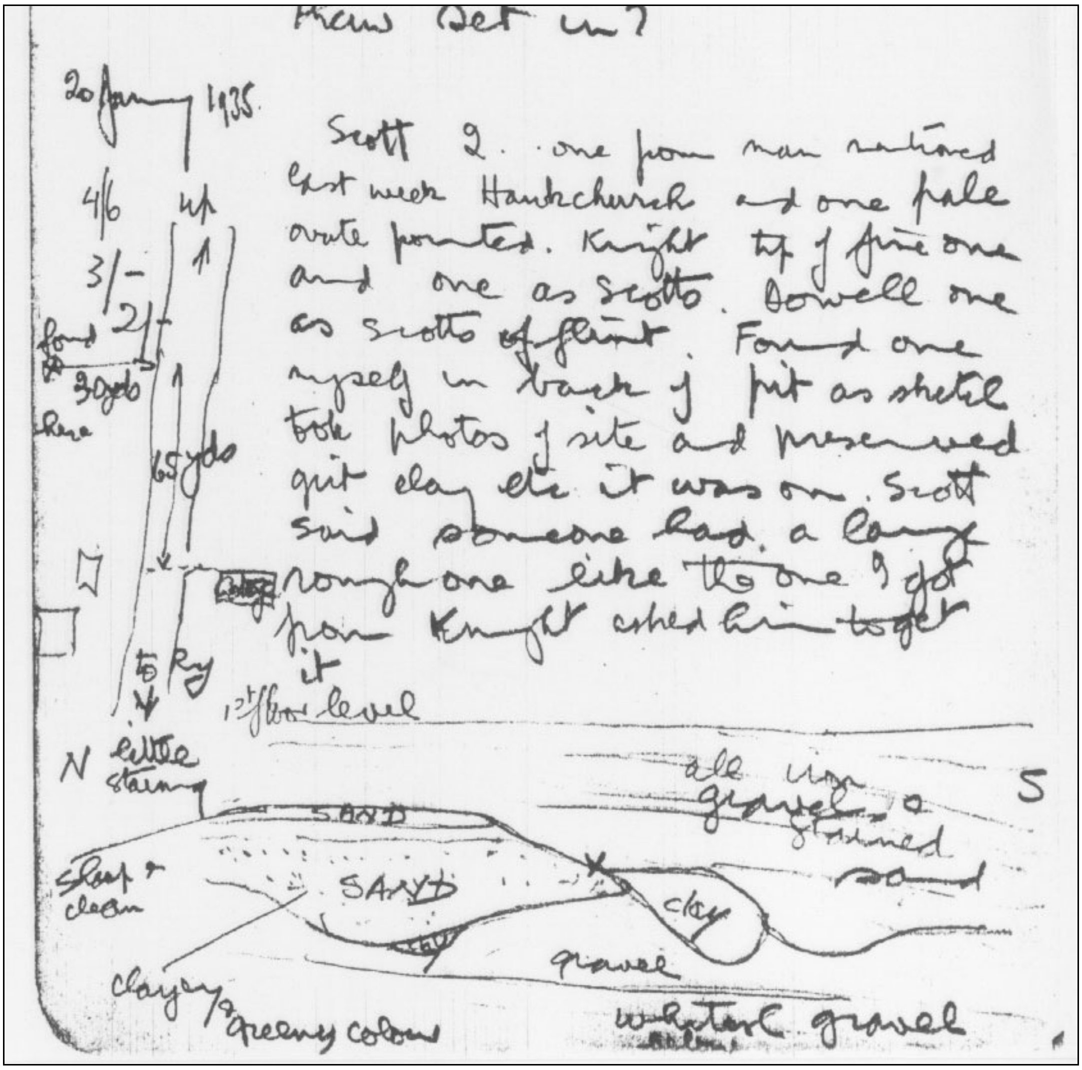

Figure 120: plan and section sketch of Pratt's Old Pit, Broom by C.E. Bean (20th January 1935)

eastern end of the working pit, the original ground surface was at *c.* 50m OD (in 1932), roughly 5m above the surface of the River Axe floodplain. Work at these levels continued until the autumn of 1935 (Figure 120–Figure 125), mainly exposing a reddish coloured gravel. Bean's photographs indicate crude bedding in the gravel, while irregular units of finer-grained material were evident at varying levels. There is some confusion as to the identity of this unit, since Green's (1988: 174–176) description suggests that this is the upper gravel, although the stated elevations (47.5–49.0 O.D.) indicate that it may represent the middle beds, as described by Shakesby & Stephens (1984; Green 1988: 174). Bean's entry for February 24th 1935 records that the pit output was approximately 60 tons per day (*c.* 330 tons per week) and he estimated that 150 tons of excavated gravel was yielding 6 bifaces.

In 1935, excavation extended below the previous pit floor, exposing a paler-coloured lower gravel. This gravel was subsequently found to represent the lowest, visible unit of the Broom sedimentary sequence throughout the pit. During 1935, the excavations indicated a ridge-like swell of the lower gravel that ran from east to west across the pit. In most parts of the pit, the lower gravel was separated from the overlying reddish gravel by beds that displayed numerous lithological changes, and consisted of sand and clay as well as gravel (Green 1988: 174–175). This latter unit is most probably the Broom middle beds.

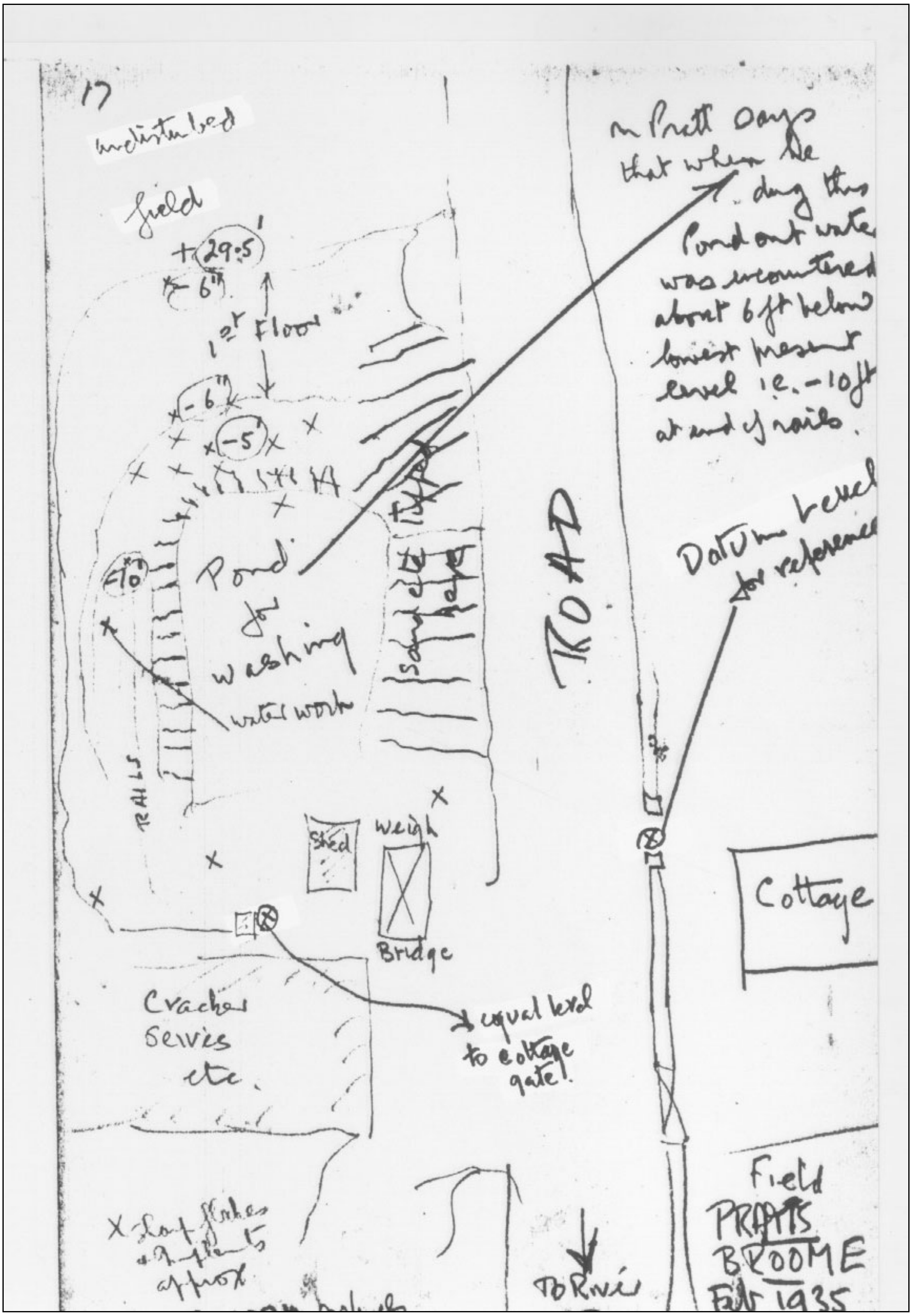

Figure 121: plan of Pratt's Old Pit, Broom by C.E. Bean (February 1935)

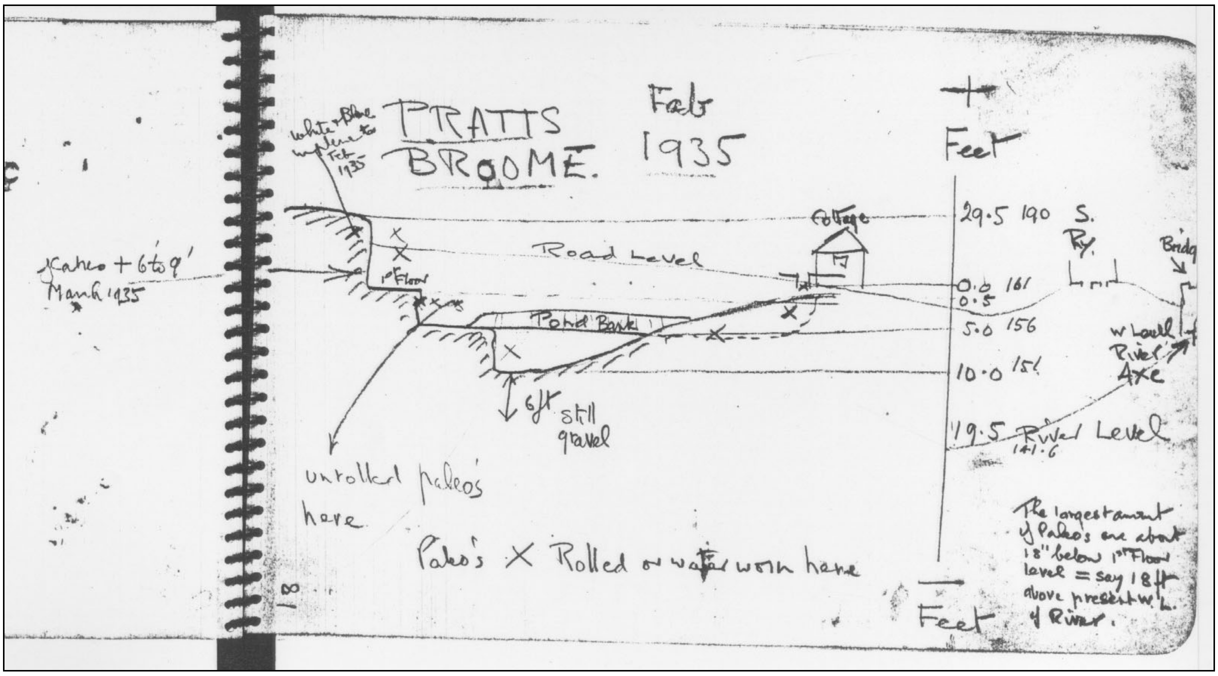

Figure 122: section of Pratt's Old Pit, Broom by C.E. Bean (February 1935)

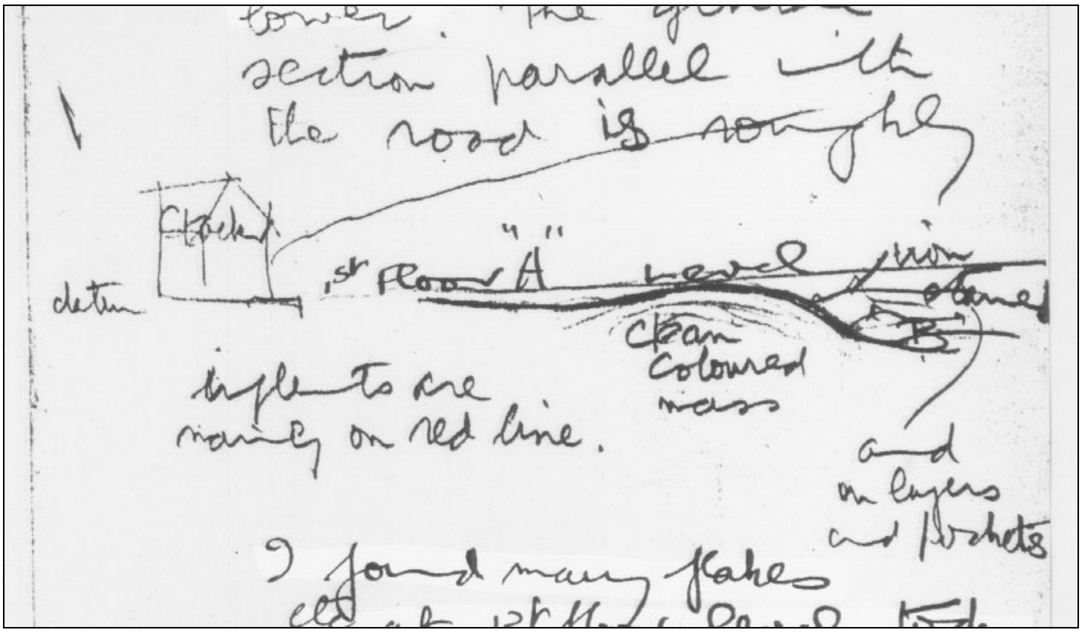

Figure 123: section sketch of Pratt's Old Pit, Broom by C.E. Bean (14th April 1935)

A brief summary of the three units is given here, following Green (1988: 175–176):

2.1.1. The Lower Gravel

The lower gravel is pale-grey or white in colour. The unit is well stratified, with horizontal bedding prevalent. Clasts are mainly smaller than in the upper gravel, while beds and lenses of sand are less common and thinner but laterally persistent, giving an impression of more regular bedding. There is occasional interruption of the horizontal beds by shallow, crossed-bedded units. Bean suggested that the gravels contained more flint than chert. The upper surface of the lower gravel lies at about 47.5m OD, rising to just over 49m OD at the crest of the swell and declining to below 47.5m in the south-eastern corner of the pit. 3.5–5.0m exposures of the Lower Gravel were provided in various parts of the pit, but its base was never seen.

2.1.2 The Middle Beds

Individual beds of this unit are limited both in thickness and lateral extent. In combination, they form a distinctive association, in which fine-grained sediments are more common than in either the Lower or Upper Gravel. Nonetheless, gravel is still the predominant lithology in the Middle Beds. The unit is separated by a sharp boundary from the Lower Gravel, but is generally less easy to distinguish from the Upper Gravel, forming irregular and discontinuous seams, lenses and masses in its lower part.

Clays and sandy-clay or loams are common with the clay beds typically brown in colour, and less commonly greenish-grey and bluish-grey. In some cases the clay beds contain scattered stones, while streaks of black staining are occasionally recorded, usually toward the bottom of the Middle Beds. Red, green and pale-coloured sands also occur in the Middle Beds. The gravels are characterised by coarse texture and open fabric, with heavy rust-coloured or black staining. These gravels beds were referred to by Bean as ‘red beds’ and are a notable feature of the Middle Beds association. The Middle Beds generally occur between 49.75m and 47.6m OD, except in the south-eastern quarter of the pit, where they descended to 45.5m OD.

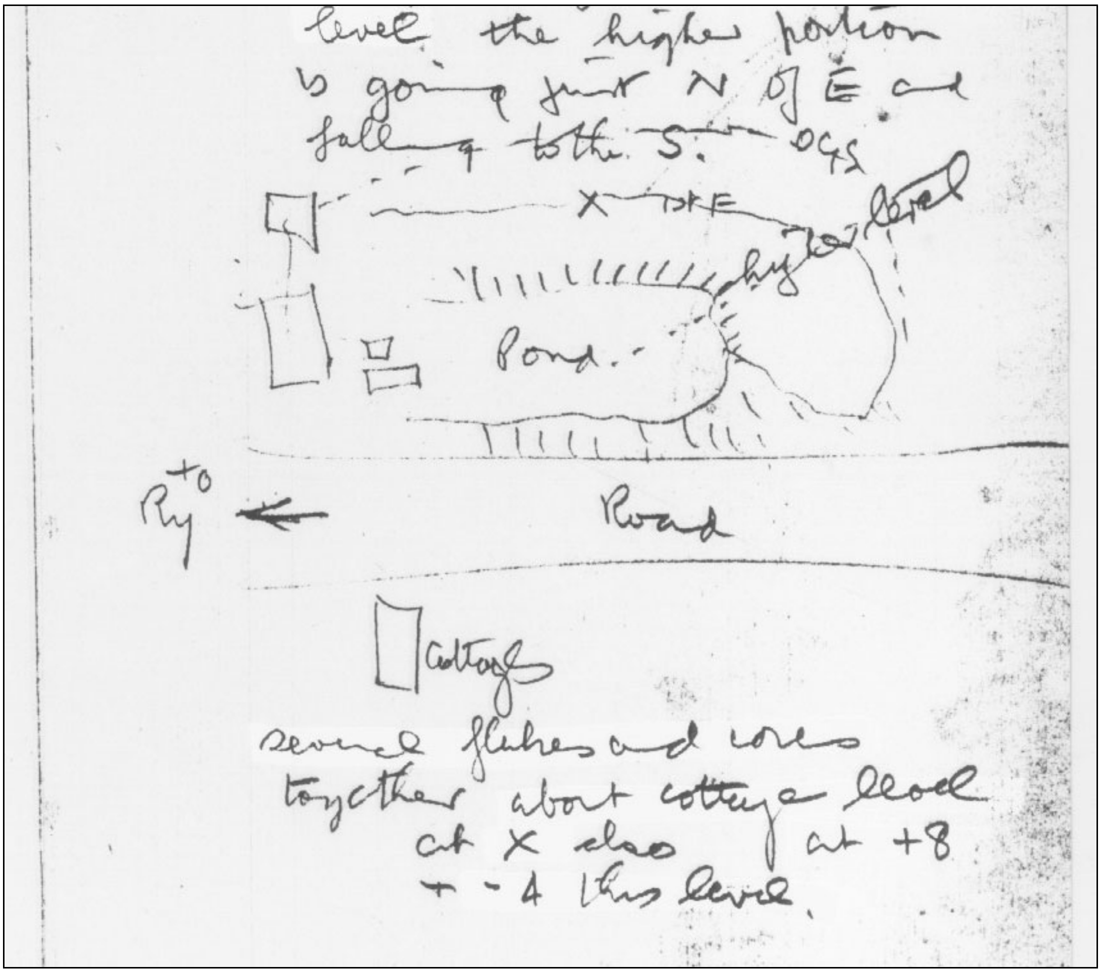

Figure 124: plan of Pratt's Old Pit, Broom by C.E. Bean (23rd June 1935)

2.1.3 The Upper Gravel

This unit is less regularly stratified than the Lower Gravel. It is generally coarse and reddish in colour, while seams, lenses and masses of sand or loam, often green in colour, are common. Up to 9m of the Upper Gravel was exposed in the Old Pit.

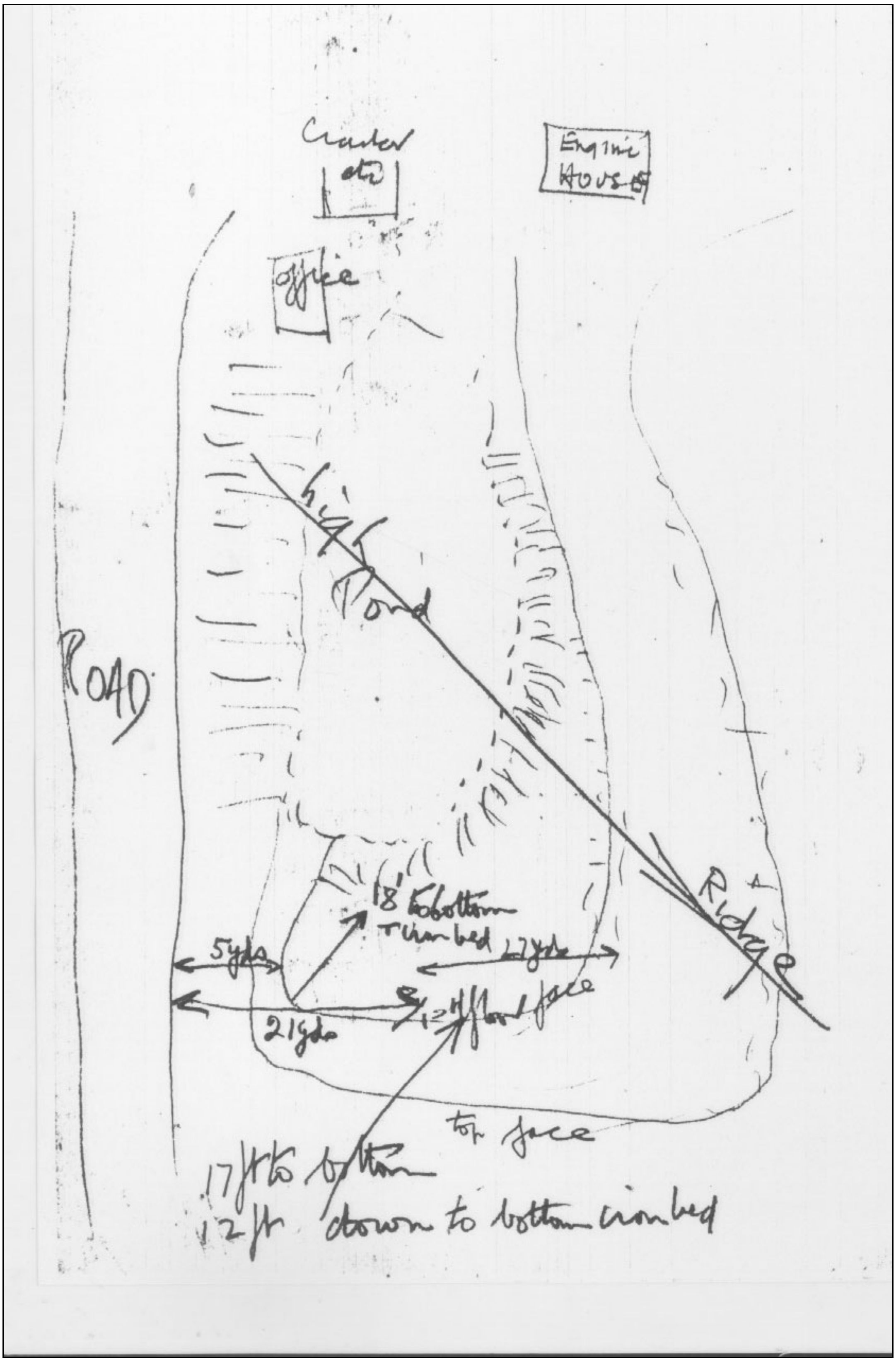

Figure 125: plan of Pratt's Old Pit, Broom by C.E. Bean (June/July 1935)

2.2 Development of the Bean archive

The archive was compiled by C.E. Bean between 1932 and 1941. Due to the absence of records for the period up to September 1933, it is not possible to plot site visits and artefact recovery rates for the entire period (*c.f.* Sampson 1978), although Green (1988) recorded the following patterns:

"Before 1935, 165 implements were acquired but few details of provenance are noted. Between February and December 1935, 24 visits were made to Broom, and 111 implements were acquired (apparent rate of recovery 0.36 implements per day). The provenance of many of these implements is recorded. In the following nine months the site was not visited. Then between September 1936 and March 1938, 17 visits were made to the site and 140 implements were acquired (apparent rate of recovery 0.26 implements per day). Provenance is infrequently recorded. During the next ten months, to the end of 1938, 507 implements were acquired (rate of recovery 1.68 implements per day). Many of these implements came from one small area…and details of provenance are recorded in considerable detail. After January 1939 few implements were found. The material acquired in 1941 included implements from the New Pit to the south of Holditch Lane."

(Green 1988: 177)

It is clear from the Bean's notebook entries that much of the artefact material and the information regarding their provenance came from the workmen at Broom. Although Green (1988: 176) has argued that there is no indication that purchase prices (for artefacts) varied according to their provenance in the pits, Bean himself was aware of the limitations of the recorded information, observing that:

"The Dowel family are prone to fabricate sites which they think will please you or enhance the values."

(C.E. Bean archive, 24th March 1935)

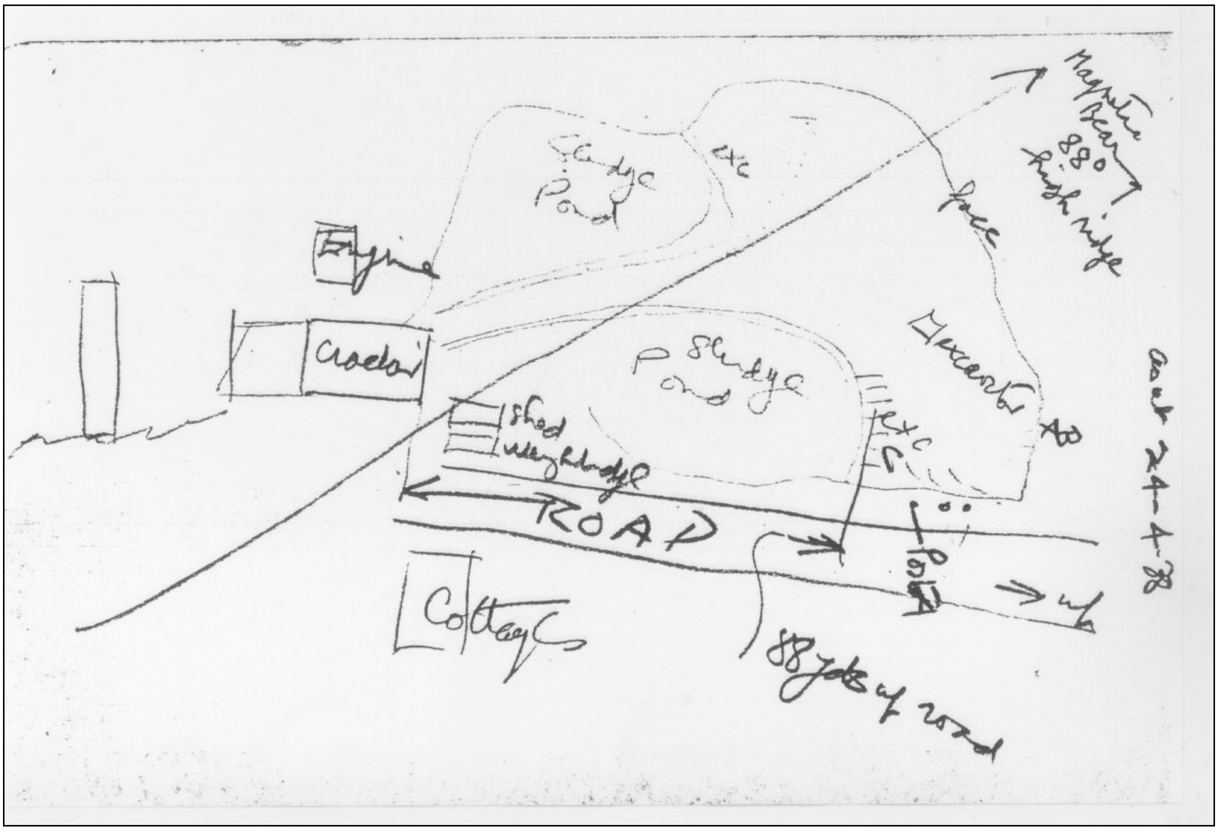

Figure 126: plan of Pratt's Old Pit, Broom by C.E. Bean (24th April 1938)

So as in many cases where artefact recovery was primarily undertaken by the pit employees, caution must be given to the interpretation of the stratigraphic data from Broom (e.g. Roe 1981). As noted by Green (1988: 177), the quality of the provenance data in the Bean archive does vary considerably. In some cases, artefacts are simply listed by number and associated with the labourer who recovered them or sold them to Bean:

"18th August 1935	*2/-*	*Scott one no 264*
	2/6	*Collins Hawkchurch one no 265"*

(C.E. Bean archive, 18th August 1935)

In other cases, much more information was recorded, including the depth and location within the pit from which the artefact was recovered:

"7th July 1935	*1/-*	*Pratt gave me one he had found near engine house at datum level no 246*
		Picked out 252 about 12 ft below 1st floor level in bottom of iron bed clayey patch"

(C.E. Bean archive, 7th July 1935)

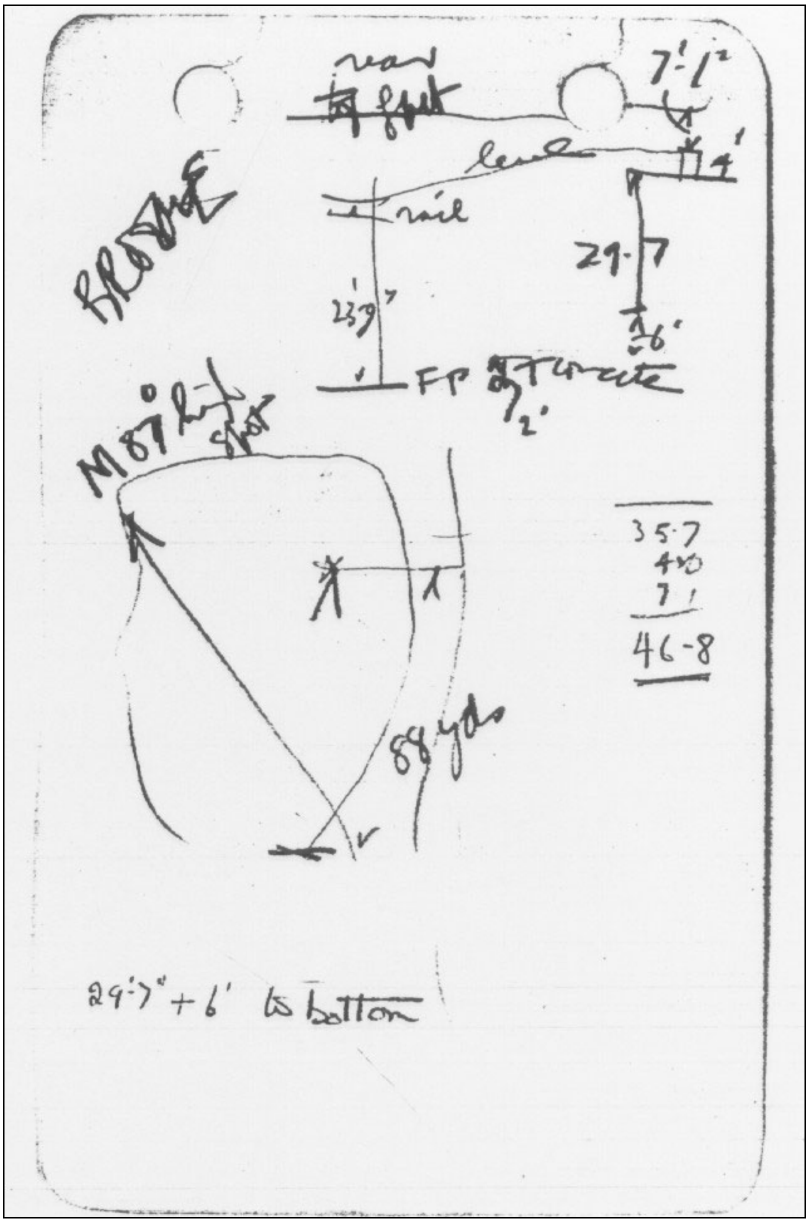

Figure 127: sketch plan and levels of Pratt's Old Pit, Broom by C.E. Bean (April/May 1938)

Two of the commonest references with respect to the depth of the artefacts are the '1st floor level' and the 'datum level', indeed there are several references to apparently unrolled material from the levels at, or immediately below, the site datum. Both the datum level and the 1st floor are clearly marked on Bean's sketches (Figure 121 & Figure 122), and although the datum (a cottage threshold on the south side of Holditch Lane) no longer exists, its height (approximately 49m OD) was reconstructed by Green (1988: 178). Figure 122 suggests that the 1st floor level lay approximately 6 inches below the datum level. Following Green (1988), these levels and the frequency of artefact descriptions relating position to the datum (e.g. "*From the lower level, in the 'Red Bed' at -2–+2 road level cottage [datum level]*") form the basis of the attempts to sub-divide the assemblage by the stratigraphic position of the artefacts (Section 4).

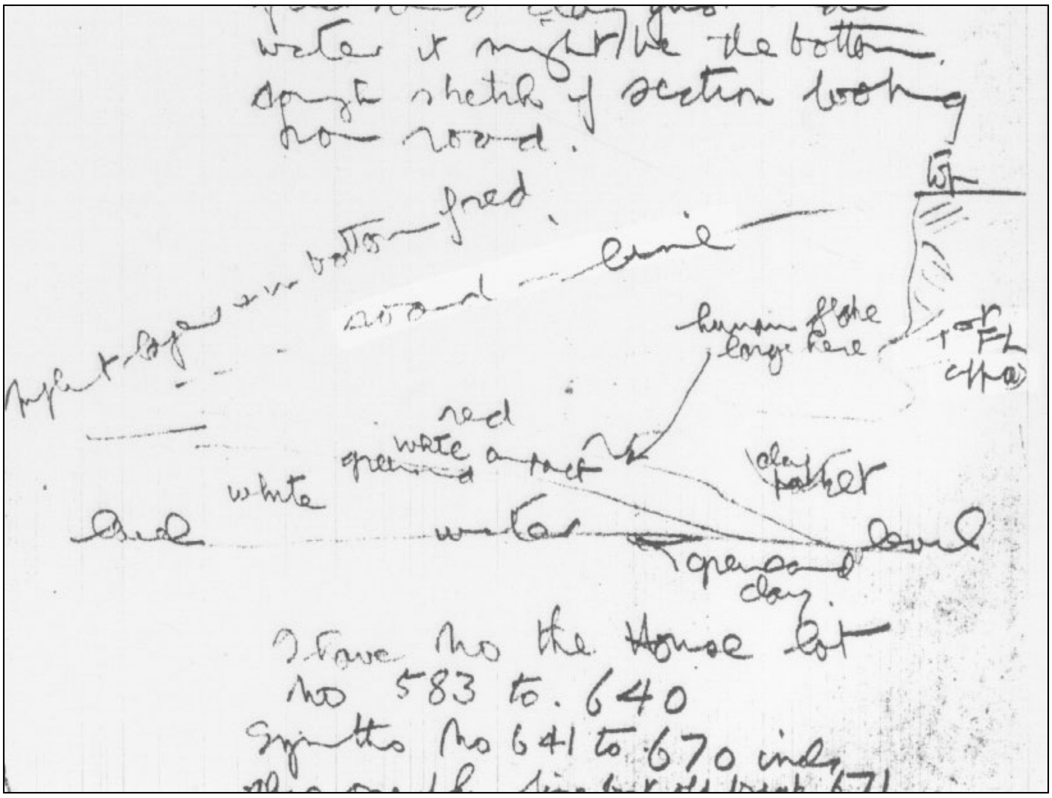

Figure 128: section sketch of Pratt's Old Pit, Broom (26th June 1938)

Green (1988: 179) notes that the majority of the Palaeolithic artefacts with recorded levels lay in the Middle Beds. He suggests that they were most common (63%) in the iron-stained gravels (the so-called red beds), which were the source of many of the isolated, individual specimens. The Bean archive suggests that a relatively concentrated collection of rolled and unrolled material was recovered during 1938 from deposits of the Middle Beds type, abutting the southern edge of the pit that runs parallel with Holditch Lane. In this area (referred to by Green (1988) as the '1938 Locality'), the upper surface of the Lower Gravel was inclined towards the east and fell below its normal level of 47.5m OD, to approximately 45.5m OD. Individual elements of the overlying Middle Beds dipped conformably with the surface of the Lower Gravel. The Lower Gravel was overlain by a bed of compact sandy-clay (yellowish white in colour) that contained bifaces, débitage flakes and large blocks of chert, all of which were in an apparently unrolled condition (but see later comments regarding Bean's classification of artefact abrasion). This bed was overlain by a 'red bed' comprising approximately 0.6m of heavily iron-stained gravel, with a coarse texture and open fabric. Bifaces and débitage flakes (both rolled and unrolled) were found in this bed, while the workmen reported that concentrations of up to 30 bifaces had been found in this bed:

"they once found 30 in a heap in centre of red bed…all ovates" [Unfortunately the Bean archive does not clearly indicate the artefact numbers of these ovate bifaces]

(C.E. Bean archive, 27th November 1938)

At its western end, the 'red bed' passed upwards into the Upper Gravel, although a clear boundary is absent. However, immediately above the 'red bed' (and sometimes penetrating into it), were numerous seams, pockets and irregular bodies of fine-grained sandy-clay material, from which bifaces were recovered. As Pratt's Old Pit was worked eastwards, the sandy-clays were found to form a continuous bed that was subsequently encountered in all areas at the eastern end of Pratt's Old Pit, and throughout Pratt's New Pit (dug immediately to the south of Holditch Lane). Bifaces were found (albeit in smaller numbers), in Pratt's New Pit beneath the clay layer, in beds that were very similar to those forming the lower part of the Middle Beds in the 1938 Locality in Pratt's Old Pit.

2.3 Bean's artefact archive

In his recording of the artefacts, Bean documented 12 variables:

1. Shape (Bean created 17 shape categories: Figure 129, Figure 130 & Figure 131).
2. Raw material (flint or chert).
3. Waterworn condition (much rolled, medium rolled, slight(ly) rolled, sharp and very sharp).
4. Colour (white, grey, blue, yellow, brown, dark brown, honey and light honey, although it become apparent during the examination of the archive that a wider range of colour categories were ultimately employed by Bean).
5. Weight (ounces).
6. Height, thickness & width (inches)
7. Depth found.
8. Whole or broken.
9. Projections (this category is rather ambiguous, with Green (pers. comm.) suggesting that it refers to unflaked or incompletely flaked areas interrupting the regular outline of the implement. Although entries under this variable are infrequent, they tend to refer to 'at side' or 'on side').
10. Remarks (the most common entries refer to the location of the knapping platform (at the base or at the side), the quality of the implement (e.g. very rough or fine), or its geo-chemical modification (e.g. evidence of iron-staining).
11. Year found.
12. Edge profile (although the accompanying sketch is rather unclear, the categories would appear to be S, reversed S, straight and sinuous).

The Bean collection is dominated by chert implements (97%, n=871), with a small number of flint artefacts (3%, n=29). This is unsurprising given the local geological setting, with the River Axe cutting through Foxmould Chert Beds of Upper Greensand, exposing bands of sandstone and chert up to 35m thick. It has also been noted that other lithic raw materials in this region are relatively rare, limited to river gravel flint cobbles, a fresh flint chalk outcrop at Beer, and a fine-grained, black chert, that was known to have outcropped at the east Dorset/West Devon coast during Mesolithic times. The current analysis (see below) has identified cobbles as the probable blank form for 52% (n=12) of the sampled flint implements with a known blank form (n=23), with the remainder formed on flakes (n=8) and nodules (n=3). This suggests that raw material acquisition (at least for flint) may have been a primarily local activity (although it is noted that the blank forms for 58% (n=32) of the sampled flint artefacts are unknown).

The bifaces are dominated by Bean's type 4 (Figure 129). This is best described as a 'lop-sided' ovate or cordate, or amygdaloid form (51%, n=457 — these figures different slightly from those presented by Green (1988: Figure 5). Bean noted that the bulge or swelling generally contained a platform or the site of a knapping platform, suggesting technological affinities with the side-struck flakes of the African Acheulean (e.g. the Victoria West tradition — Goodwin 1929; Fluck 2002). However, the current analysis has indicated that where a knapping platform can be identified, it tends to occur in the butt region of the biface rather than on the sides. In other words, there is no evidence for European/African links in technological practise. The other main types in the Broom assemblage are Bean's type 10 (12%, n=109), which has general affinities with Wymer's pointed (type F) and sub-cordate (type G) bifaces; type 3 (8%, n=76), broadly similar to Wymer's pointed (type F) biface; type 5 (7%; n=65), suggestive of Wymer's ovate (type K biface); and type 16 (6%, n=62), with parallels to Wymer's sub-cordate (type G) biface. One of the key goals of the current analysis of the assemblage was therefore to classify the bifaces according to the Wymer terminology, facilitating comparison with other assemblages. The most important aspect however, concerned an evaluation of the apparent dominance of the amygdaloid form. An initial, visual inspection of the Bean collection had suggested that these types did not comprise over 50% of the assemblage. A focus was therefore placed on the identification of asymmetrical ovate forms ('amygdaloids') during the re-examination of the collection. Of equal importance was to examine whether specific types occurred throughout the stratigraphic sequence or only at specific locations within the fluvial deposits.

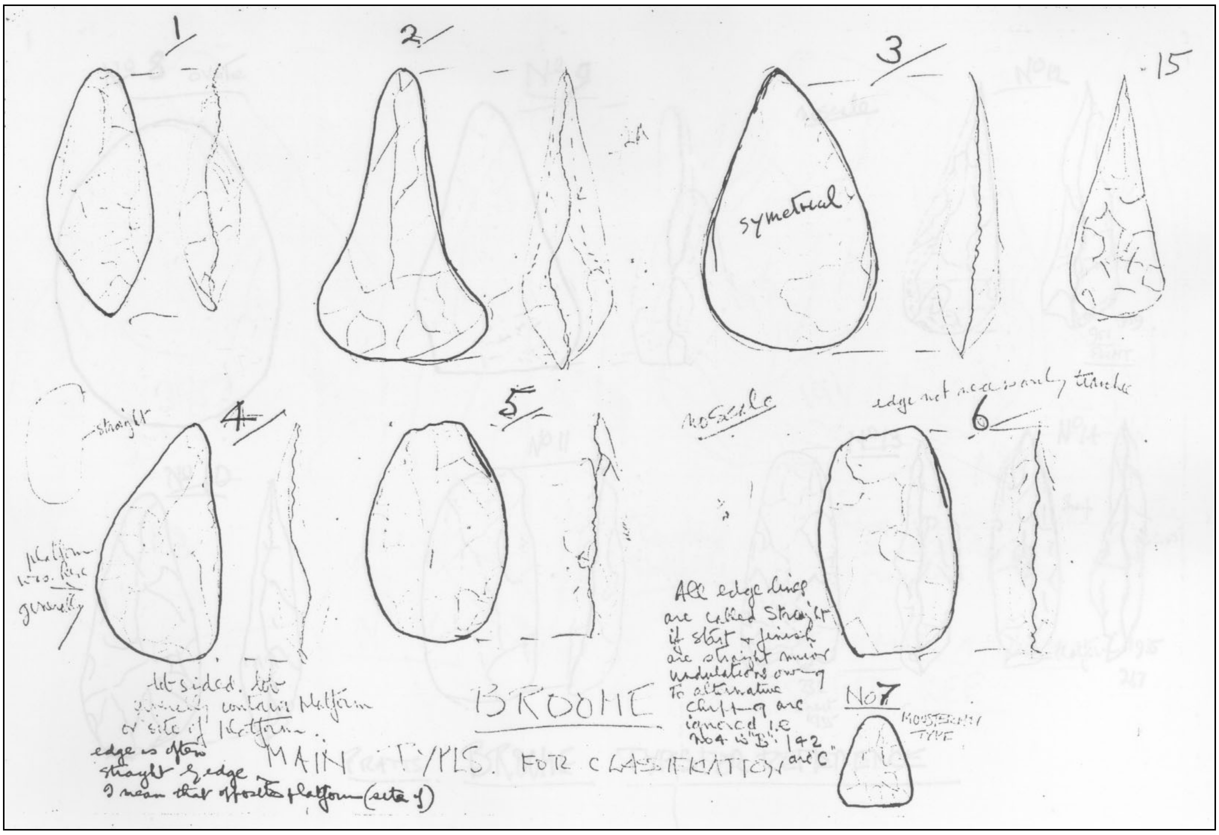

Figure 129: C.E. Bean's biface shape types (1, 2, 3, 4, 5, 6, 7 & 15).

Physical condition	n	%
Not recorded	1	0.1
Much rolled	18	2.0
Medium rolled	37	4.1
Slight(ly) rolled	122	13.5
Sharp	601	66.7
Very sharp	122	13.5
Total	**901**	**100.0**

Table 30: Broom artefact abrasion categories by C.E. Bean

Bean's characterisation of the abrasion of the artefacts is difficult to assess, since his criteria for distinguishing, for example, sharp and much rolled implements cannot be assessed quantitatively. Nonetheless, his records suggest that the majority of the assemblage was probably only subject to a minor amount of fluvial transportation and damage. Sharp condition implements dominate the assemblage (67%, n=601), with significant proportions of very sharp (14%, n=122) and slight(ly) abraded (14%, n=122) implements (Table 30). The key goals for the re-analysis were therefore a quantified study of artefact abrasion and testing whether there was evidence for homogenous 'clusters' and/or *in situ* material within the assemblage.

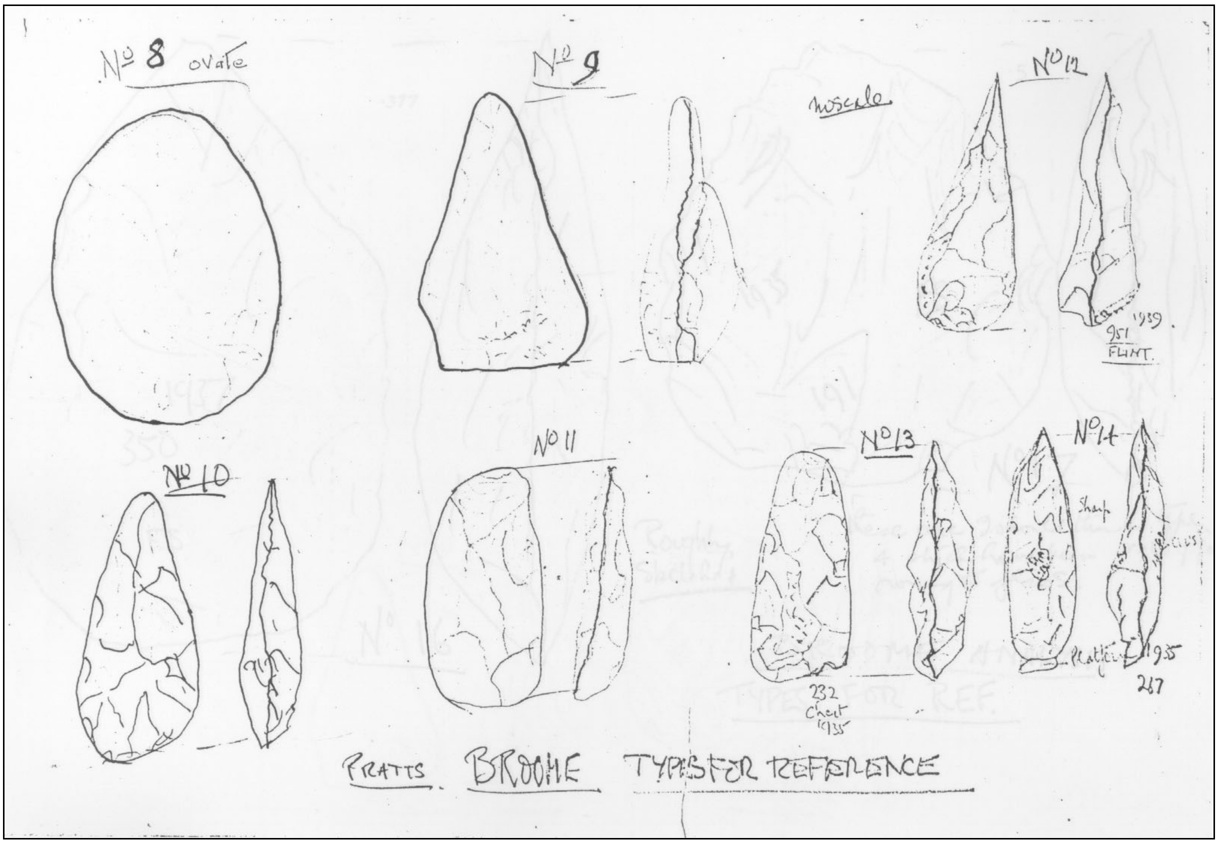

Figure 130: C.E. Bean biface shape types (8, 9, 10, 11, 12, 13, & 14)

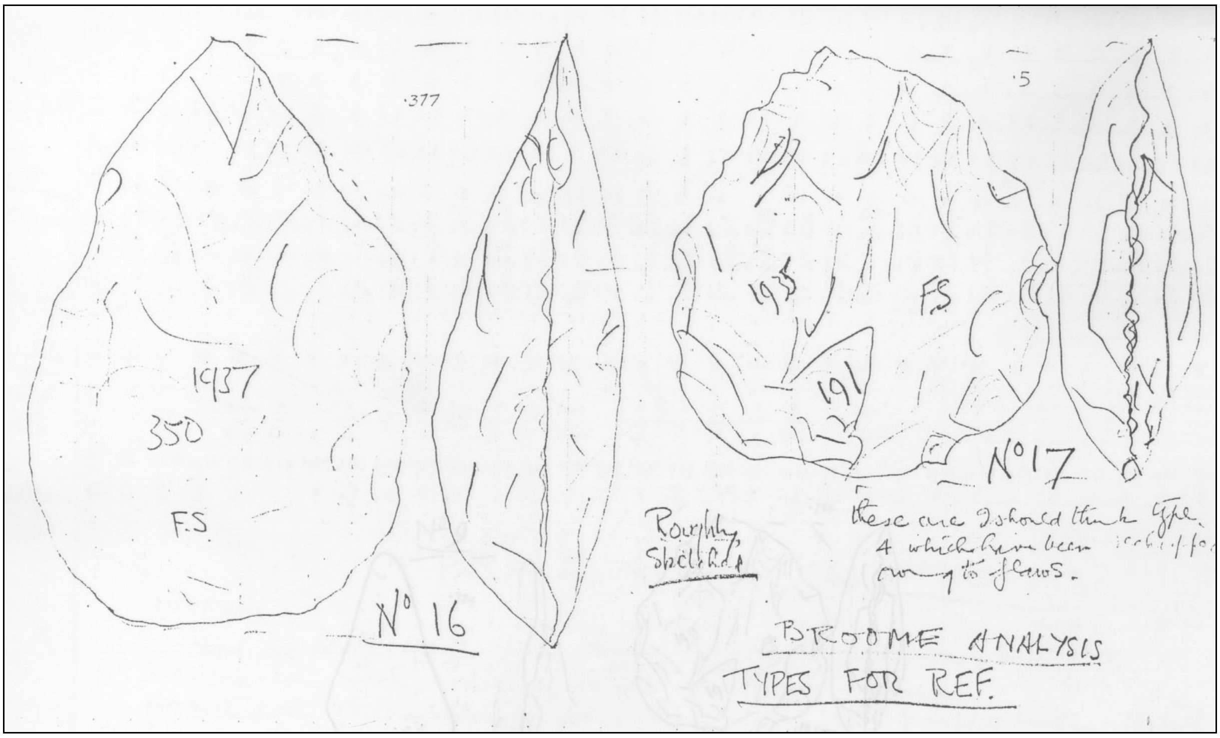

Figure 131: C.E. Bean biface shape types (16 & 17)

3. CURRENT ANALYSIS OF THE BROOM ASSEMBLAGE

977 bifaces were sampled, 767 from the Bean collection and 210 from the Royal Albert Memorial Museum and Art Gallery, Exeter collection. 188 non-bifaces were also sampled from the Bean collection (Table 31), of which 33 'artefacts' were found to be natural upon re-examination. 45 non-bifaces were sampled from the Royal Albert Memorial Museum and Art Gallery, Exeter collection, along with a further 50 bifaces, which were not subjected to detailed analysis due to their physical condition. Although the total number of artefacts from the Broom deposits remains unclear, the current re-investigation has suggested a minimum total of 1321 (Table 36), based partially on the previous work of C.P. Green (1988).

Green's analysis of the Bean collection and documentary archive (Green 1988: 177) concluded that it comprised "over 900 hand-axes of Acheulian type, together with waste flakes, unfinished implements and large blocks of unworked, or roughly prepared, chert" (although only 899 hand-axes were listed in the accompanying summary tabulation (Green 1988: Table 1). Conversion of the Bean archive into a digital database as part of the current project suggested 901 bifaces, and this total is broadly in-keeping with the previous work of Green. Bean's own archive records that he collected 1003 implements from Broom between 1932 and 1939, and examination of the archive suggest that he used the term implement to refer to bifaces and (occasionally) diagnostic flake tools such as scrapers and 'flake knives'. An additional difficulty concerns the absence of 83 artefact identifier numbers (in the sequence 1–1058) and the duplication of 35 artefact numbers (and other symbol identifiers) in the Bean archive and on the physical artefacts (Table 32 & Table 33). Green (pers. comm.) produced an overall summary for the Bean collection (Table 34) that indicates a total of 1016 Broom artefacts in the Bean collection (including material from the Railway Ballast Pit, Pratt's Old Pit and an additional pit, referred to as the Council Pit).

Examination of the artefacts collections at the Royal Albert Memorial Museum and Art Gallery, Exeter collection indicated a total of 260 bifaces and 45 non-bifaces (Table 35). The source of these artefacts is not clear, but it is assumed that they represent material collected from both the Railway Ballast Pit and Pratt's Old Pit (Bean's own archive makes numerous references to material being sold to other collectors during the 1930's when he was visiting the pit). There is also documentary evidence for the trade in Broom artefacts from the Railway Ballast Pit during the late 19th century (Section 1.1, Chapter 3).

It is clear that any current estimate of the size of the Broom assemblage is a minimum, rather than a maximum value, due to the existence of Broom artefacts in museums other than Exeter, the unknown destination of artefacts collected or purchased by parties other than C.E. Bean

Artefact Type	Sample size
Blade	1
Broken Roughout	1
Core Scraper	1
Denticulate	1
Flake	24
Biface Fragment	23
Biface Butt	2
Biface Tip	5
Notched Scraper	1
Retouched Flake	46
Rock	33
Roughout	5
Roughout Fragment	1
Scraper	12
Uniface	31
Uniface Fragment	1
Total	**188**

Table 31: non-bifaces artefact sample from the Bean collection

Artefact Identifier Numbers					
67	92	102	123	144	148
151	179	184	207	252	271
272	286	289	295	302	304
305	308	320	325	327	328
329	332	334	351	357	358
359	367	368	369	373	375
381	407	409	410	414	430
527	559	662	670	754	759
803	973	974	975	976	977
978	986	1032-1058			

Table 32: missing artefact identifier numbers in the C.E. Bean Broom collection and documentary archive

Artefact Identifier Numbers					
16	22	100	107	189	190
239	264	265	267	269	270
281	315	343	356	418	419
514	530	583	589	620	623
689	689	755	761	928	956
1013	- (Page 27)	… (Page 27)	5.. (Page 24)	No nº (Page 28)	

Table 33: duplicate artefact identifier numbers in the C.E. Bean Broom collection and documentary archive (page numbers refer to the documentary archive)

Artefact Source	Sample size
Bean collection (incl. flakes)	980
Broom (Pratt's Pit) – number obscure	4
Broom (Pratt's Pit) – unnumbered	29
Broom (Railway Pit)	2
Broom (Council Pit)	1
Total	**1016**

Table 34: total artefacts in the C.E. Bean collection (calculated by C.P. Green (pers. comm.). Pratt's Pit refers to Pratt's Old Pit.

Artefact type	Sample size
Bifaces	260
Flakes	15
Retouched flake	8
Scraper	17
Uniface	2
Knife	1
Notch	1
Roughout	1
Total	**305**

Table 35: total artefacts from Broom in the Royal Albert Memorial Museum and Art Gallery, Exeter collection

Source	Total
Bean collection	1016
Royal Albert Memorial Museum and Art Gallery, Exeter collection	305
Total	**1321**

Table 36: minimum totals for the Broom artefact assemblage

3.1 Biface typology

Examination of artefact typology using the Wymer (1968: Fig. 27) matrix of biface shapes classification (Figure 132) broadly duplicated many of the patterns suggested by Bean's earlier work. Cordate/ovate

(28%, n=272), cordate (19%, n=183), and pointed (11%, n=109) forms were dominant, with smaller proportions of ovate (7%, n=65) and sub-cordate (6%, n=54) bifaces and other transitional forms (e.g. sub-cordate/cordate, pointed/sub-cordate, and sub-cordate/ovate bifaces). Bean's types 3, 4, 5, 10 and 16 displayed affinities with all of these types, and while direct correlation of the two schemes is rather impractical, the general patterns suggested are similar.

The key difference however, concerns the absence of a single dominant type in the Wymer scheme, unlike the status of the lop-sided ovates/amygdaloids in the Bean scheme. In the current analysis, lop-sided forms were characterised by the presence of macroscopic asymmetry in the artefact plan form. This contrasted with a recent study by Binyon (2002), who statistically manipulated digital images to classify artefact symmetry and asymmetry. However, it is argued here that for artefact symmetry/asymmetry to be significant, it must have been discernable to the knapper at the time of manufacture (rather than just to pixel detection routines), hence its classification by eye in this research. These types comprised only 24% (n=232) of the sample, suggesting that while these artefacts form a significant element of the Broom assemblage, they are not as dominant as suggested by Bean. These asymmetrical, lop-sided forms were associated with a range of Wymer types, although as with the total sample, cordate/ovate (42%, n=98) and cordate (22%, n=50) biface types were the two main categories. The presence/absence of biface types in the total assemblage and the asymmetrical and plano-convex samples is summarised in Table 37.

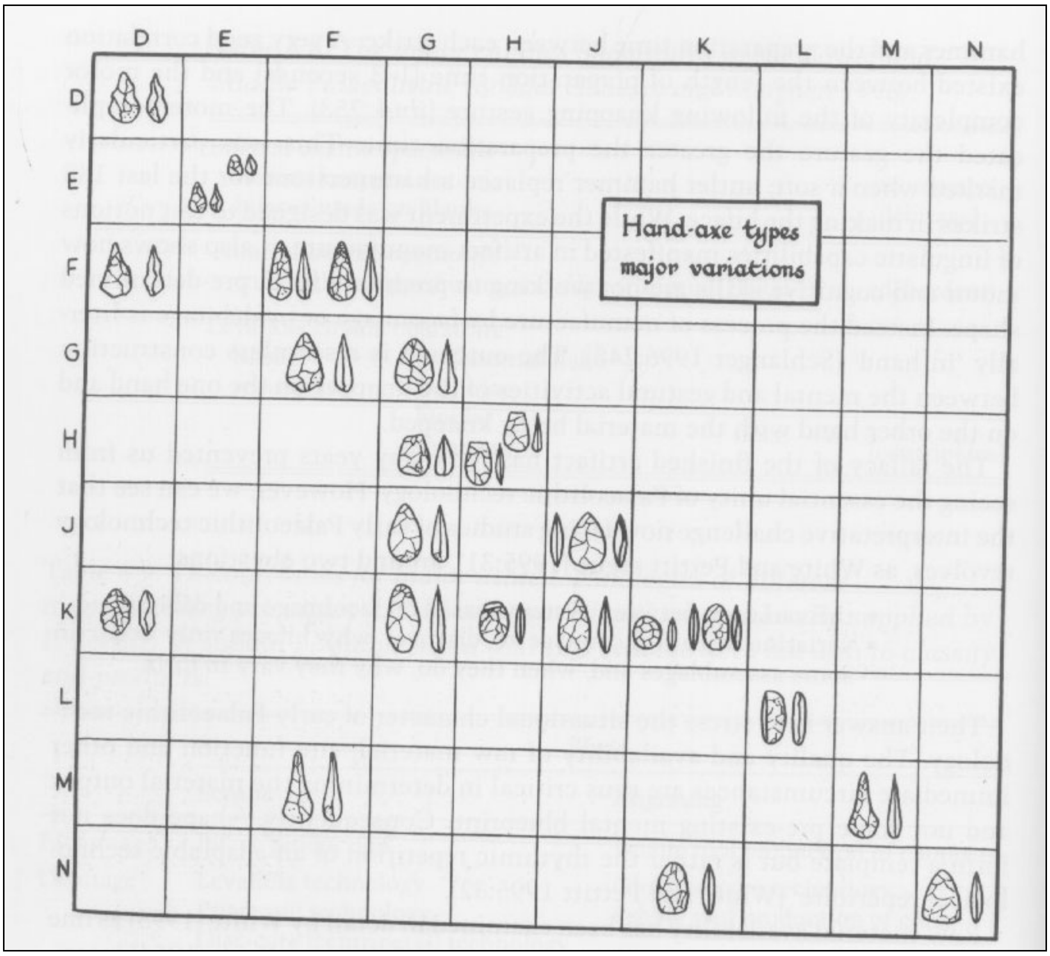

Figure 132: Wymer (1968: Fig. 27) matrix of biface shapes. D: stone-struck crude biface. E: small, irregular biface. F: pointed biface. G: sub-cordate biface. H: cleaver. J: cordate biface. K: ovate biface. L: segmental 'chopping' tool. M: ficron biface. N: flat-butted cordate biface (or bout coupé).

There are only small numbers of distinctive typological forms, although they are present in the assemblage. These types include 25 ficrons (3%, including pointed/ficron forms), 26 cleavers (3%, including ovate/cleaver and sub-cordate cleaver forms) and 12 flat-butted cordates (1%, including ovate/flat=butted cordate forms). As with the lop-sided forms, one of the key goals of the analysis was to investigate whether these distinctive types occur throughout the Broom sequence or are localised in their distribution. However (and unlike the lop-sided forms), the very small numbers of these types does introduce the problems of sample size. Nonetheless, it is noticeable that with the exception of 1 pointed/ficron form, none of these types were produced in association with the lop-sided forms, reflecting the tendency of the latter to occur in association with ovates and cordates.

Biface types	**Types present**	**With plano-convex profiles**	**With asymmetrical plan form**
Crude stone-struck (D)	✓	✓	×
Crude stone-struck/Pointed (DF)	✓	✓	×
Small, irregular (E)	✓	✓	×
Pointed (F)	✓	✓	✓
Pointed/Sub-cordate (FG)	✓	✓	✓
Pointed/Ficron (FM)	✓	✓	×
Sub-cordate (G)	✓	✓	✓
Sub-cordate/Cleaver (GH)	✓	✓	×
Sub-Cordate/Cordate (GJ)	✓	✓	✓
Sub-Cordate/Ovate (GK)	✓	✓	✓
Cleaver (H)	✓	✓	×
Cleaver/Ovate (HK)	✓	✓	×
Cordate (J)	✓	✓	✓
Cordate/Ovate (JK)	✓	✓	✓
Ovate (K)	✓	✓	✓
Ovate/Flat-butted cordate (KN)	✓	✓	×
Segmental chopping tool (L)	✓	×	×
Ficron (M)	✓	×	×
Flat-butted cordate (N)	✓	✓	×

Table 37: presence/absence of Wymer biface types in Broom assemblage

There is also a significant element of the biface sample that is plano-convex in profile (21%, n=204). However, following the patterns seen in the overall sample and lop-sided sub-sample, these bifaces are dominated by cordate/ovate (30%, n=61) and cordate (17%, n=35) types. Cleavers, ficrons and flat-butted cordates were also produced (albeit in small numbers) with plano-convex profiles.

Biface tips were dominated by irregular rounded (45%, n=439), rounded (15%, n=145) and ogee points (10%, n=98), which is relatively unsurprising given the dominance of cordate/ovate, cordate, pointed and ovate forms in the overall assemblage. However, field-based experimental work by Hosfield & Chambers (Afon Ystwyth Experimental Archaeology Project) and flume-based experimental studies by Chambers have observed that biface tips are vulnerable to damage and potential modification during fluvial transport. The analysis of tip type patterning in this archaeological assemblage is therefore restricted to robust trends. However, it is noticeable that there is a very small presence of tranchet tips (1%, n=10) in the assemblage.

Biface butt forms were dominated by trimmed flat (54%, n=531) and trimmed (21%, n=201) types, suggesting a preference for circumferential cutting edges, which also corresponds with the dominance of ovates, cordates and cordate/ovates in the assemblage. Interestingly, there was also a significant presence of natural (10%, n=98) and part trimmed/part cortex (12%, n=121) types, suggesting a diverse approaches to knapping of the biface butt, either extensive flaking (the dominant technique) or minimal working (only 25 of the bifaces showed evidence of partial trimming).

3.2 Biface morphology

The biface sample was dominated by specimens weighing between 100g and 500g (mean = 422.07g, mode = 334g, median = 393g; Figure 133). The distribution had a wide range (range = 2399g) and was strongly skewed, with a long tail to the right (skewness = 1.5414; kurtosis = 6.7895), reflecting the presence of a small number of heavier artefacts in the sample.

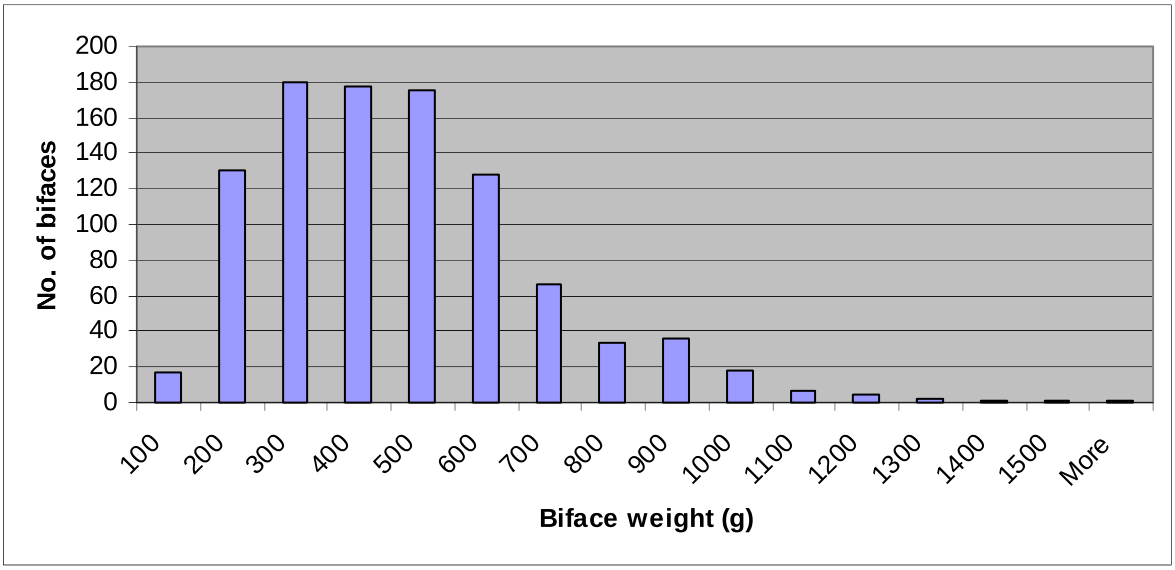

Figure 133: biface weight distribution (class interval = 100g)

The pattern of biface weight distribution contrasts with the distributions of both biface length (Figure 134) and breadth (Figure 135), both of which display normal distributions, with short tails and little evidence of skewness ($skewness_{length}$ = 0.2354; $kurtosis_{length}$ = 0.3654; $skewness_{breadth}$ = -0.1760; $kurtosis_{breadth}$ = 1.0687). The biface sample (by length) is dominated by artefacts between 100 mm and 160 mm in length (mean = 133.02 mm, mode = 138.80 mm, median = 131.80 mm). The biface sample (by breadth) is dominated by artefacts between 60 mm and 105 mm (mean = 86.84 mm, mode = 94.70 mm, median = 87.70 mm).

The pattern of biface weight distribution shows stronger parallels with the distribution of biface thickness (Figure 136), which displays a slightly skewed distribution with a tail to the right (skewness = 1.0509; kurtosis = 5.4324). The biface sample (by thickness) is dominated by artefacts between 20 mm and 50 mm (mean = 34.67 mm, mode = 34.2 mm, median = 34.2 mm).

However, the correlation coefficients (r) between the four variables, indicate that the strongest positive relationship exists between biface length and weight (r = 0.89), followed by biface breadth and weight (r = 0.82) and thickness and weight (r = 0.72). The correlation coefficients also indicated that the relationships between biface length and thickness (r = 0.65) and breadth and thickness (r = 0.54) were relatively weak, suggesting that there was not a clear relationship between increasing length/breadth and thickness in the biface assemblage.

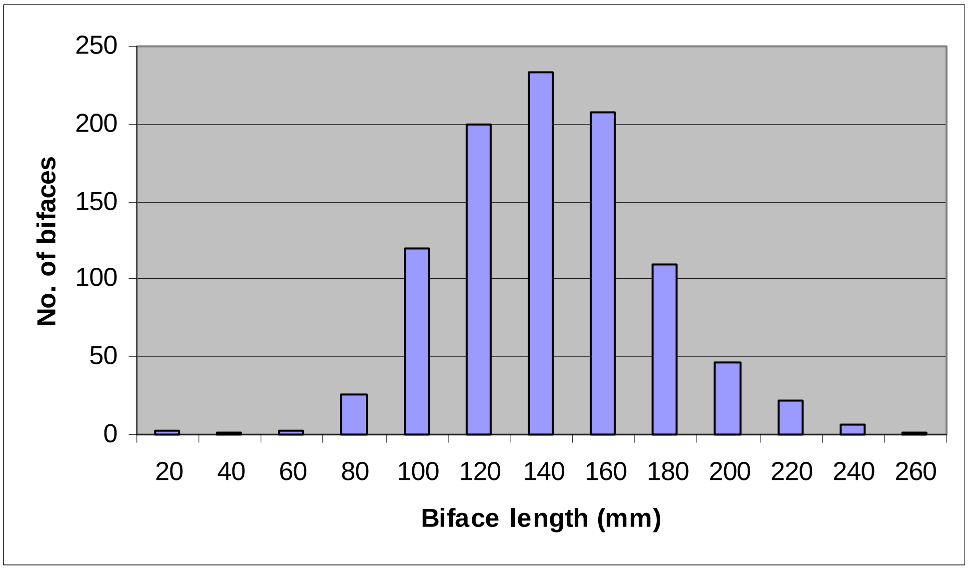

Figure 134: biface length distribution (class interval = 20 mm)

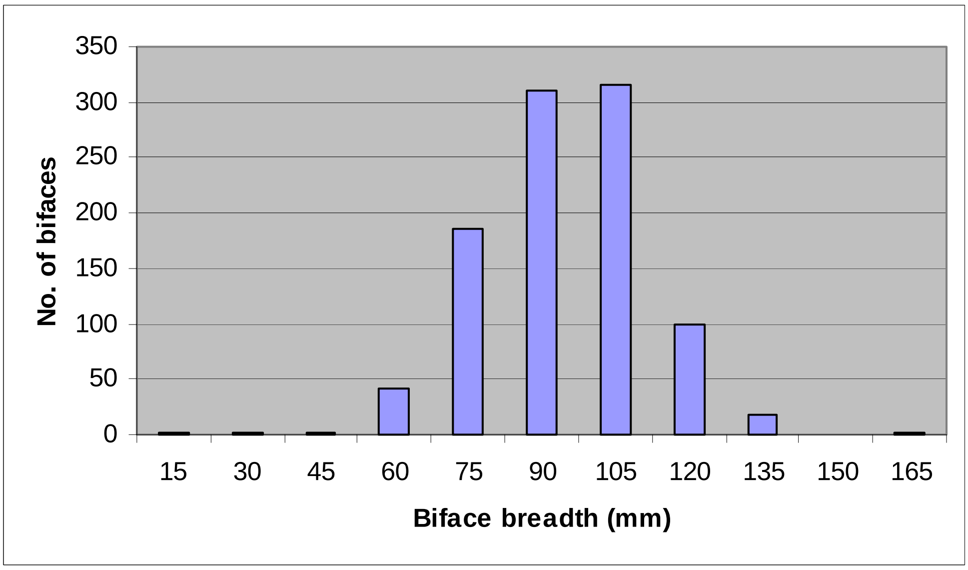

Figure 135: biface breadth distribution (class interval = 15 mm)

3.3 Biface technology

3.3.1 Raw Materials

Following the work of Bean, the majority of the biface sample was produced in chert (94%, n=921), with a small sample of flint bifaces (6%, n=55) and a single example made from quartzite. The chert was sub-divided during recording into fine-, medium- and coarse-grained chert, which suggested that coarse-grained material was least frequently used (18% of the total sample, n=178), although fine-grained chert (28%, n=269) was also in a minority in comparison with medium-grained materials (49%, n=474).

The ratios for the production of the major artefact forms (ovates, points, cordates and sub-cordates) in the different raw material types showed no significant differences to the overall proportion of raw material types recorded in the assemblage (Table 38). The data therefore indicate no support for the selective use of raw material to produce different biface forms (*c.f.* White 1998b).

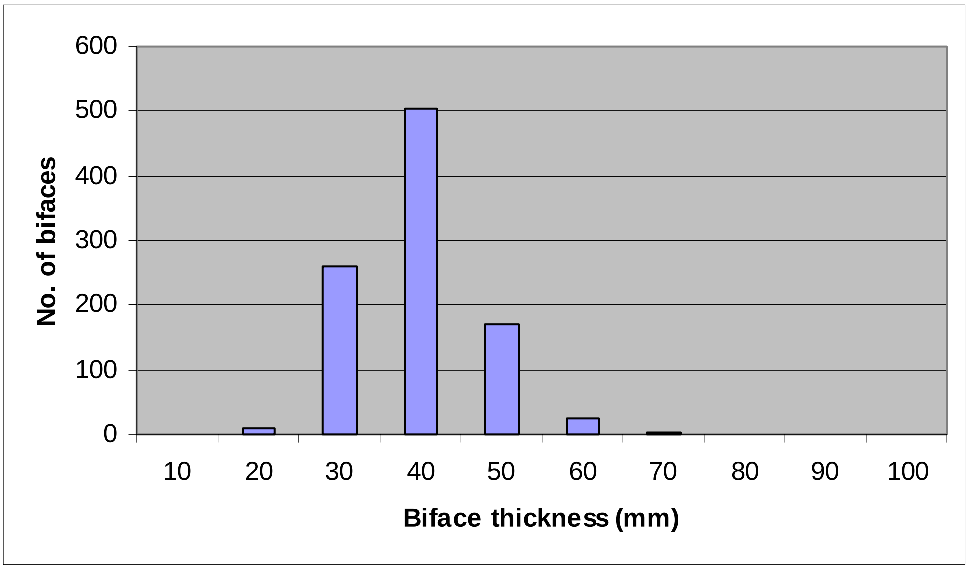

Figure 136: biface thickness distribution (class interval = 10 mm)

Artefact Type	Raw Material Category							
	Flint		Fine-grained chert		Medium-grained chert		Coarse-grained chert	
	%	n	%	n	%	n	%	n
Point	7.18	14	27.69	54	49.74	97	15.38	30
Ovate	5.00	20	25.50	102	48.75	195	20.75	83
Cordate	5.11	27	26.89	142	49.05	259	18.94	100
Sub-cordate	6.56	17	28.96	75	45.95	119	18.53	48
Assemblage	5.64	55	27.56	269	48.57	474	18.24	178

Table 38: biface types by raw material category ('transitional' types, e.g. ovate/cordate are counted in both categories. % values calculated for each row)

The proportions of distinctive biface types (cleavers, ficrons and flat-butted cordates) produced in each raw material category were also generally similar to the overall sample. In the case of ficrons, the majority of artefacts were produced on fine- (32%, n=8) and medium-grained (40%, n=10) chert, with small numbers produced on coarse-grained chert (12%, n=3) and flint (16%, n=4). Cleavers were predominantly produced on medium-grained chert (52%, n=13), with smaller numbers produced on fine-grained (36%, n=9) and coarse-grained chert (12%, n=3). Given the small sample size, it is difficult to attribute significance to the absence of cleavers produced in flint. Flat-butted ovates were also mainly produced on medium-grained chert (50%, n=6), with small numbers made on fine-grained chert (33%, n=4), flint (8%, n=1) and coarse-grained chert (8%, n=1).

The plano-convex bifaces in the assemblage were produced on all the assemblage raw material types, in ratios very similar to the overall sample: medium-grained chert (46%, n=94); fine-grained chert (27%, n=56); coarse-grained chert (21%, n=43); and flint (5%, n=11).

3.3.2 Blank Forms

Identifying the blank forms used in biface production is typically difficult as diagnostic features such as flake butts, bifacial cortex, tabular cortex and cobble cortex are commonly removed during the process of turning a blank into a biface. In the majority of cases at Broom, identification of blank form was not possible (60%, n=590). In those cases where a positive identification was possible, flakes were the dominant blank type (53% of the positively identified sample, n=205), although there was also a significant number of cobbles (24%, n=94 — these values increase to 39%, n=149 if naturally fractured cobbles and flaked cobbles are added to the cobble sample). There were no clear relationships between blank form and the distinctive bifaces types (cleavers, ficrons, flat-butted cordates), although this analysis was hindered by the difficulty in assessing blank form and the small numbers of the three distinctive biface types in the assemblage. This was also the case with the relationship between blank form and tranchet flake removals, which showed no clear patterns.

The major biface types did demonstrate some interesting patterns with respect to blank form. Points showed little preference (where the blank form could be identified) for production on either cobbles or flakes (cobbles 52%, flakes 48%), while sub-cordates, cordates and ovates all showed a preference (once again, where the blank form could be positively identified) for production on flakes (sub-cordates: 78%; cordates: 74%; ovates: 100%). Given the difficulty of blank form identification, caution is advisable with the interrogation of this pattern, but it is interesting that the highest proportion of flake use is associated with ovate forms, suggesting parallels with the conclusions of White (1998b).

3.3.3 Edge Profiles

The biface edge types are dominated by sinuous and straight edges. The most dominant pattern is a two straight edges (47%, n=455), with significant examples of one straight and one sinuous edge (27%, n=266) and a two sinuous edges (22%, n=212). There are very few examples of S-twist profiles, either on both edges of a biface or just one edge (4%, n=37). Moreover, in many cases the S-twists are not pronounced, and in no examples were they as diagnostic as the S and Z-twisted ovates documented by White (1998a). For all examples of the S-twist profiles, there was no suggestion of selective production in particular raw materials, with medium-grained chert (60%, n=22) dominant, and smaller amounts of the other materials: fine-grained chert (30%, n=11), coarse-grained chert (5%, n=2), and flint (5%, n=2). With respect to blank forms and S-twist profiles, the sample was too small to draw any clear patterns, although it may be significant that both cobbles (n=2) and flakes (n=5) were present in the sample.

These patterns in edge form are also very similar for the sub-sample of lop-sided forms, suggesting that there were few differences in the techniques of production for these asymmetrical bifaces. The two straight edges pattern is again dominant (50%, n=116), with a significant presence of bifaces with one straight and one sinuous edge (28%, n=66) and bifaces with two sinuous edges (17%, n=40). As previously, S-twist edges are rare (3%, n=7). The sub-sample of plano-convex bifaces also demonstrated these broad patterns, with the two straight edges dominant (47%, n=96), with a significant presence of one straight and one sinuous edge bifaces (34%, n=69) and a small number of two sinuous edges (18%, n=36).

There was no noted pattern in the relationship between sinuous edge profiles and cobble blank forms. Where sinuous edges occurred on either one or both profiles, flake blanks (including side-struck flakes) occurred in 64% (n=70) of cases, compared to 36% (n=39) for cobbles (including flaked cobbles and naturally fractured cobbles). Where sinuous edges occurred on both of the biface profiles, flake blanks occurred in 62% (n=53) of cases, compared to 38% (n=32) for cobbles. In both instances, the ratio of blanks to cobbles was similar to that shown for the entire assemblage, suggesting that there was not a premeditated selection of cobbles for rapid, on-the-spot production of ‘crude’, relatively unrefined bifacial tools.

There was some evidence of variation from the general edge profile pattern when the distribution was examined in terms of biface butt types, although the overall patterns were generally similar to the complete assemblage. In all instances, the two straight edge types was dominant, but it was highly dominant in the partly trimmed butt category (75%, n=18), whereas in all other cases the figure varied between 41% and 49% (excluding the part trimmed flat category with a sample size of 1). The straight edge/sinuous edge and sinuous/sinuous edge categories were the other major types present. The straight/edge sinuous edge type ranged from 12.5% (associated with part trimmed butts) to 33% (associated with part trimmed/part cortex butts), while the sinuous/sinuous edge type ranged from 12.5% (natural and part trimmed butts) to 28% (trimmed butts).

3.3.4 Biface Refinement

There was little evidence to suggest that there was a relationship between raw material and the degree of biface refinement (as measured by a % cortex index and a number of flake scars index). For flake scars to be counted they had to greater than 1 cm in any dimension. This avoided the potential confusion caused by the inclusion of micro-flaking (caused by fluvial transport) to the edges of the biface. The average number of dorsal flake scars ranged from 16.8 (coarse-grained chert) to 20.3 (flint), with the average number of ventral flake scars ranging from 14.1 (coarse-grained chert) to 18.2 (flint). Although there was a small increase in average flake scar numbers with increasingly fine-grained raw material, the data did not suggest a clear relationship between manufacturing refinement and raw material quality.

Similarly there was no clear evidence for a raw material quality/biface refinement relationship in the pattern of biface cortex. Average dorsal cortex % values ranged from 5.9% (medium-grained chert) to 8.6% (fine-grained chert), while average ventral cortex % values ranged from 6.8% (coarse-grained chert) to 10.6% (fine-grained chert). In this instance, there was no clear linear relationship between average cortex % and increasingly coarse-grained raw material.

3.4 Biface Transport

Assessment of whether the bifaces had been subjected to fluvial transport was based on a range of recorded attributes, the quantified abrasion (width) of the bifaces' flake scar ridges (following Wymer 1968; Shackley 1974, 1975; Hosfield 1999); the presence, intensity and location of micro-flaking on the biface edges; and the presence, density and location of incipient percussion cones on the artefacts' dorsal and ventral faces. It was apparent that all of the bifaces had been subject to some degree of fluvial transportation, although it was also clear that relatively few had been transport long distances.

Modelling the distances that each artefact may have been transported prior to deposition is much more complicated, and the full methodology is outlined in Section 4. In outline, it involves a combination of quantified abrasion data, experimental archaeological data, artefact profiles (e.g. plano-convexity and the presence/absence of a biface 'spine'), and photographic evidence. The modelled distances (Figure 137) were, of course, never intended as absolute distances — but it is suggested that the robust nature of the data do indicate some probable patterns with respect to the sources and generic catchment of the assemblage.

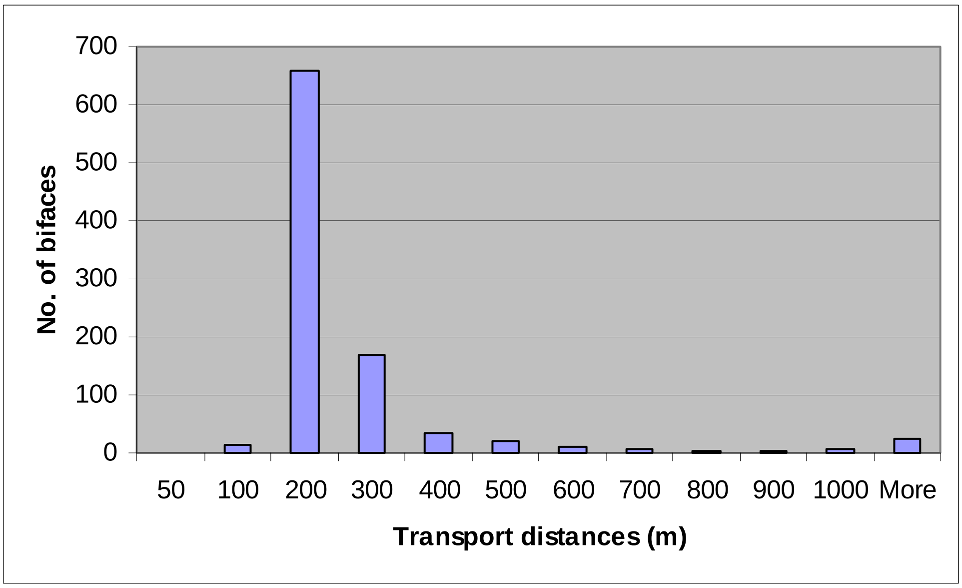

Figure 137: biface transport distances (modelled) distribution

The data suggest that the majority of the bifaces (*c.* 89%) have been fluvially transported a short distance, probably less than 200–300m, prior to their incorporation into the sediments at Broom. Nonetheless, there is a significant component of the assemblage that has probably been transported over greater distances, probably more than 500–1000m.

3.5 Summary

The biface assemblage from Broom is summarised as follows:

1. A predominance of cordate/ovate, cordate and pointed forms (Wymer types J/K, J and F), with cordate, ovate and cordate/ovate (intermediate) forms representing over 50% of the sampled assemblage.
2. Cleavers, ficrons, and flat-butted cordates are present, albeit in small proportions.
3. The typological composition of the assemblage is broadly replicated in the plano-convex and asymmetrical (lop-sided) sub-samples.
4. Tip types were dominated by irregular, rounded forms, although the vulnerability of tips to damage during fluvial modification restricted the significance of any subtle patterning.
5. Tranchet tips were present, but in very small numbers.
6. Trimmed flat butts were dominant, suggesting a preference for fully circumferential cutting edges on the bifaces.
7. Biface weight was clustered between 100g and 500g, although there was a total weight range of 2399g.
8. Fine and medium-grained cherts were predominantly utilised for biface production. There was no association between the grain size of the raw material and the types of bifaces produced.
9. Although positive identification was difficult, bifaces produced on both flake and cobble blanks formed significant elements of the assemblage. There is weak pattern indicating a possible preference for flank blanks in the production of sub-cordates, cordates and ovates.
10. The biface edges were dominated by straight and sinuous profiles. These patterns held true for the plano-convex and asymmetrical sub-samples. S-twist profiles were relatively rare and rather equivocal. There were no clear associations between S-twists and raw material quality, or between sinuous edges and the use of cobble blanks.
11. There was no evidence of any relationship between raw material quality (fine to coarse-grained) and the degree of biface refinement (measured by the number of flake scars and the percentage of unremoved cortex).
12. Although all of the assemblage has been subject to fluvial transportation, the majority of the bifaces appear to have been derived from a nearby source and have probably been transported only a few hundred metres prior to deposition into the sediments at Broom.

3.6 The non-biface assemblage

The non-biface assemblage consisted of a range of artefact types, including biface fragments, débitage flakes, retouched flakes, scrapers, unifaces and roughouts (Table 31 & Table 35). The ratio of non-biface to biface material (1:5.14) is in marked contrast to the ratios resulting from experimental knapping activity, as demonstrated by Newcomer (1971), who produced four bifaces and generated 195 flakes (although their size was not specified), and Wenban-Smith (1996), who created four bifaces, generating 210 flakes ≥ 20 mm. It indicates that the material is not in primary context (i.e. that hominids were not episodically knapping bifaces and other tools on the surface of the fluvial sands and gravels, as those sediments were deposited upon the floodplain), although it is also likely that the ratio is depressed due to the tendency of the pit labourers to ignore flake materials. The presence of roughouts indicates that bifaces were being produced in the vicinity of Broom. The presence of other tool types (particularly scrapers and retouched flakes) suggests that the assemblage is not purely the product of a biface manufacturing site, but rather that other activities were also undertaken.

Nonetheless, the stratigraphic origins of the non-biface material, particularly the flakes, are significant since the presence of débitage material in fluvial sediments has often been taken as evidence of assemblages that are either in primary context or have suffered minimal disturbance and transportation. The Bean archive indicates the collection (both by the Pratt's Old Pit labourers and by Charles Bean himself) of flakes from throughout the sequence — the coarse-grained upper and lower gravels and the finer-grained middle beds. However, the majority of references to flake material are associated with the datum level (the approximate height of the middle beds):

"I found many flakes in the large stone bed equals about road level cottages to -2 ft [the general level of the middle beds].*"*

(C.E. Bean archive, 3rd March 1935)

"Found several flakes in face exposed about 3 ft above floor level cracker [the general level of the middle beds]…*the cores and flakes look very fresh."*

(C.E. Bean archive, 9th June 1934)

"Found several flakes and a rough implement about 12" below 1st floor level [the general level of the middle beds].*"*

(C.E. Bean archive, December 1934)

"Found many flakes myself just below first floor [the general level of the middle beds] *in compact bed at back of pit."*

(C.E. Bean archive, 27th January 1935)

It is difficult to assess Bean's claims for 'fresh' flakes, mainly due the problems of identifying flakes with a clear stratigraphic provenance in the Bean collection. Nonetheless, the current analysis suggests that the majority of the flakes showed evidence of some degree of fluvial transport. It is concluded, therefore, that the majority of the flakes recovered from Pratt's Old Pit were probably found in association with the middle beds and that these flakes were probably subjected to short distances of transport in the low-energy flow conditions that deposited the fine-grained sediments of the middle beds. Nonetheless, there is also evidence for the presence of flakes in the coarse-grained upper and lower gravels:

"Many flakes 2' above datum = Rd level cottage in stiff clayey sand [the middle beds]…*found core or at least, I think it is, at 13 ft above datum also at about 10 ft above datum flakes etc* [the height of the upper gravels].*"*

(C.E. Bean archive, 7th April 1935)

"Several flakes and cores together about cottage level at X [the middle beds] *also at +8*[ft] *and -4*[ft] *this level* [the upper and lower gravels].*"*

(C.E. Bean archive, 23rd June 1935)

"Large flake at 10 ft deep back of pit = 19 ft above datum [the upper gravels].*"*

(C.E. Bean archive, 18th August 1935)

The presence of flakes in the upper and lower gravels suggests that the Broom sequence does not represent a single, minimally disturbed occupation (the archaeology of the middle beds), surrounded by occasional stray biface finds in the coarse-grained sediments above and below. The general condition of three flakes recovered from the upper gravels in Pratt's New Pit (during the 2002 excavations by the University of Southampton) also indicates that these flakes were fluvially transported and not discarded by hominids on the floodplain. Detailed transport modelling of the non-biface assemblage was not undertaken due to the very small numbers of suitable flake scar ridges on these artefacts.

In general therefore, the presence of flakes in the Broom sequence has been documented from the Bean archive, the Bean collection and the finds from the current excavations. However, despite the reference to cores within the Bean archive (see above), the current analysis has been unable to identify any core material within the Bean collection.

Examination of the assemblage indicated no evidence of Levallois material (either flakes or cores), although Wessex Archaeology (1993b) did list 2 flakes and 1 core. This discrepancy cannot currently be resolved, although even if these artefacts were located, their small numbers would necessitate caution with respect to the behavioural interpretation of the Broom assemblage. Nonetheless, the presence/absence of Levallois material obviously carries implications with respect to artefact-chronologies for the British Isles (Bridgland 1996). Examination of the Bean collection also yielded a single large blade. The flint blade is not abraded, edge damaged, stained or patinated, suggesting that it may have originated from the surface at Broom and therefore be far younger in age. However, it is also difficult to demonstrate that this artefact was the product of systematic blade production, and it could have been produced during the reduction of a tabular nodule.

Overall, the presence and probable condition of the non-biface artefacts at Broom suggests that the entire sedimentary sequence contains bifaces, non-bifaces (e.g. unifaces and scrapers) and flakes that have been derived (albeit over relatively short distances) from upstream areas and re-deposited in the floodplain sediments at Broom.

4. ARTEFACT ABRASION AND TRANSPORTATION

This section provides a detailed account of the new methodology developed by JCC to model the spatial origins of bifaces recovered from secondary fluvial contexts. This work forms part of JCC's recently submitted PhD thesis (Chambers in prep.) and has been utilised in the current project given its suitability for the research questions being investigated here.

4.1 Introduction to artefact abrasion studies

It has long been noted that artefacts recovered from river gravels display a range of physical modifications resulting from the high-energy depositional conditions they have been subjected to. Thus the *état physique* of such artefacts can be utilised as an indicator of how far from their original point of discard within the landscape they have been fluvially transported.

With regard to artefact abrasion, studies have focused on the degradation of biface arêtes (flake scar ridges). In freshly knapped bifaces arêtes rise thin and proud from the body of the biface. As artefacts become incorporated within active fluvial systems they behave as clasts, rolling, saltating, sliding and colliding with other clasts. These impacts reduce the height and increase the width of the arêtes. Such damage increases with time and transportation, and the recognition that artefacts are not all abraded to the same states facilitated a gross interpretation of the degree of transportation within high-energy contexts that the artefacts had been subjected to. Artefacts, such as bifaces, with sharp edges and little visible abrasion to the arêtes found in association with knapping débitage and perhaps faunal remains were considered to remain in close proximity to their original point of use and discard. Those artefacts that displayed 'very rolled' characteristics were considered to have been transported significant distances within the river channel environment.

Two major approaches for quantifying artefact abrasion have been proposed (reviewed below); those based on a visual assessment of the relative degree of damage an artefact has sustained (e.g. Wymer 1968) and those based on techniques pioneered by Shackley (1974; 1975) that utilise microscopic technology to objectively measure arête widths in micrometres.

4.2 Visual assessment of biface abrasion

Prior to the work of Shackley, 'naked eye' visual assessment of biface abrasion was the only means by which to assess the degree of damage artefacts had sustained. These visual assessments generated a range of user-specific descriptive terms such as 'mint', 'fresh', 'worn', 'rolled'. The inherent subjectivity of such terms was compounded by an absence of standardised terminology. An attempt at standardisation was proposed by Wymer (1968: plate xi), suggesting five categories to encompass the range of abrasion damage displayed by artefacts recovered from river gravels. These categories were mint, sharp, slightly rolled, rolled and very rolled, with artefacts in the rolled and very rolled categories displaying arêtes widths of up to $^{1}/_{32}$ and $^{1}/_{8}$ of an inch respectively *(ibid.)*.

This standardisation allowed different workers to apply the same terminology to different artefacts and assemblages of artefacts, and provided a means of quantifying the most abraded artefacts recorded. However standardisation of a subjective classificatory system does not in itself reduce the potential inter-observer variability.

4.3 Microscope Techniques: objective assessment of biface abrasion

During the course of analysis of derived context lithic assemblages from the Mousterian site of Great Pan Farm on the Isle of Wight, Shackley (1973, 1974, 1975) determined that an absolute means of measuring and describing artefact abrasion was required. To avoid confusion between use wear and abrasion damage Shackley's analyses focused on the arêtes of bifaces, which she examined under an x75 microscope eyepiece calibrated to 10μm (Shackle 1975). For recording purposes, Shackley (*ibid.*) divided each biface into imaginary thirds of tip, mid and butt sections documenting the width of 25 arêtes across the entire artefact, collected roughly equally from each third. These 25 arête values were combined to produce an average observed arête width for the entire artefact. This methodology was applied to both experimental (tumbling mill abraded) and archaeological examples, providing information on artefact abrasion development, and a means with which to provide objective measurements and classification of abraded archaeological lithics. The tumbling mill experiments undertaken by Shackley (*ibid*: 43–46) revealed that a variety of factors including artefact shape, raw material, nature of abrasive material and transportation type could affect the development of arête abrasion. However, in the standardisation of abrasion recording and description, potentially subtle variations in abrasion development were obscured by the generation of an average abrasion value for the entire artefact. To further facilitate quantification of results, Shackley (*ibid.*) also proposed a scheme to correlate the commonly used verbal descriptive terms of artefact abrasion with the damage sustained by her experimental bifaces during the tumbling mill experiments (Table 39).

The generation of an average abrasion value, or index value, for each artefact provided a quantified manner of assessing both individual, and more importantly assemblages of, abraded artefacts. The recording of arête widths at the micrometer scale led to the recognition that artefacts which may not appear abraded to the naked eye, can have sustained transport-related arête damage. This is best demonstrated by Shackley's analysis of the assemblage from Great Pan Farm on the Isle of Wight (*ibid.*). Non-microscopic evaluation of the assemblage had not revealed any trace of abrasion damage and the artefacts were therefore considered to have been manufactured at a nearby occupation site and not regarded as having been subjected to any notable degree of transportation. Measurement of the arêtes of these artefacts under a microscope showed that many did indeed show traces of abrasion resulting from incorporation within active fluvial systems, suggesting that the Great Pan Farm assemblage is not as homogenous in spatial origin as visual assessment alone would suggest (*ibid.*).

Ridge Width (μm)	**Common Description**	**Shackley's Index Value**
0–10	Mint	0
10–20	Very Fresh	1
20–50	Fresh	2
50–100	Slight Abrasion	3
100–200	Abraded	4
200–300	Heavily Abraded	5
300+	Very Heavily Abraded	6

Table 39: abrasion indices and verbal description correlation (Shackley 1975)

As the example of Great Pan Farm highlights, the major motivation behind Shackley's methodology was to provide a means of assessing the integrity of 'assemblages' recovered from high-energy contexts. An implicit assumption in the consideration of such assemblages had long been that if artefacts occur in large numbers then they cannot have travelled far within the fluvial system, as sustained transportation would distribute the archaeological material over a large area. Whilst not directly addressing transport duration, a quantifiable means of assessing artefact abrasion at the sub-millimetre scale allows both the identification of homogenously abraded 'assemblages within assemblages' and, conversely, also allows for the damage and variation in seemingly non-abraded assemblages to be examined in greater detail than the human eye alone can detect.

Despite the inherent advantages in being able to provide absolute values rather than subjective descriptions for abraded arêtes, Shackley's methodology has not been widely implemented. Applications of microscope recording of archaeologically abraded lithic material appear to have been limited to the work undertaken by Shackley (1973, 1974, 1975) and a slightly revised methodology proposed by Hosfield (1999). It seems most likely that microscopic recording of artefact abrasion has not been implemented further as a result of both the perceived indecipherable nature of artefact transportation within river gravel deposits, and the time consuming nature of the technique.

4.4 Artefact abrasion and transportation (i)

As outlined above, artefact abrasion whether subjectively categorised or microscopically measured has been used as indicators of the relative amount of fluvial transportation individual artefacts or a population of stone tools have been subjected to. The development of an absolute means of recording arête abrasion damage provided a foundation for further investigations into the perceived homogeneity of large secondary context assemblages, but also for relating abrasion damage development to transportation duration in more absolute terms.

Experiments conducted by Harding *et al.* (1987) set out to investigate taphonomic aspects of secondary context assemblage formation and artefact modification. By monitoring the dispersal and damage sustained by replica bifaces emplaced within different sub-environments in the Afon Ystwyth (mid-Wales) the relationship between distance and damage could be considered.

60 replica bifaces were emplaced at different locations within the braided channel environs of the Afon Ystwyth during a period of peak discharge. Monitoring of where these artefacts were recovered and what damage they had received revealed the following (*ibid.*):

- Artefacts within active fluvial environments behave as the local mobile sediment, therefore;
- Transportation is an episodic phenomenon, with periods of movement tending to be followed by longer periods of stasis.
- There is an inverse relationship between the distance transported and artefact size.
- Biface wear also appears to be an episodic phenomenon.

Within these experiments attention focused on weight loss and polish development, rather than specific arête measurements of abrasion development. A strong relationship could be demonstrated between distance moved and weight lost, which did not appear to be related to the original size of the replica artefact (*ibid.*; these experiments are discussed in further detail in chapter 5). With regard to artefact modification as a result of fluvial transportation, the most interesting findings of the Harding *et al.* (*ibid.*) experiments are the common occurrence of weight loss resulting from the detachment of small flakes from the edges of the biface during artefact–clast impacts. This indicates that solely focusing upon the arêtes of an abraded biface will not represent the entire transportation history that an artefact preserves.

4.5 Artefact abrasion and transportation (ii)

Very few attempts have been made to correlate abrasion development and real world transportation distances, perhaps once again reflecting the perceived difficulties of unravelling the relationship between fluvially transported artefacts, their depositional contexts and the resulting damage artefacts sustain.

The most detailed research in this area is that undertaken by Hosfield (1999). Devising an adaptation of Shackley's methodology, where 15 rather than 25 data points are selected across the biface, Hosfield (*ibid.*) combined the quantitative abrasion data provided by microscopic arête width recording with the abrasion damage sustained within fluvial environments generated by the experiments of Harding *et al.* (1987) and his own experimental abrasion development data on replica artefacts.

Based on the sum of these data Hosfield (1999) devised seven preliminary rates of wear values (*ibid*: 116–117) based on differing combinations of potential abrasion values prior to the bifaces incorporation into the river environment. The expansion of this model to include a greater archaeological sample facilitated the refining of an average wear rate of 0.1475 $\mu m\ m^{-1}$. These results allow artefacts recovered from river gravel contexts to be 'back-tracked' from their findspots to a modelled discard area (*ibid*: 121). This represents a significant move towards accurately modelling hominid activities within landscapes dominated by high-energy artefact recovery contexts.

4.6 A summary of extant abrasion assessment methodologies

While the numerical dominance of Palaeoliths recovered from high-energy contexts within the Palaeolithic record of Britain, has long been acknowledged, the ways in which we try and interrogate this data set remain limited, with the visual categories proposed by Wymer 35 years ago, remaining the most commonly employed way of describing secondary context artefacts. The simplicity and speed of this technique has obvious advantages, however analysis at such a simplistic level provides no meaningful information about the duration and variety of fluvial transportation that artefacts have been subjected to. It does not facilitate the interrogation of the spatial origins of an assemblage in anything other that the most crude of terms. As artefacts recovered from secondary contexts do preserve detailed information about the nature and duration of the transportation regimes they have been subjected to, as demonstrated by the work of Shackley (1975) and Hosfield (1999), by failing to evaluate this evidence we are also failing to do justice to a substantial portion of the Palaeolithic record.

If we accept that, as Harding *et al.* (1987) demonstrated, once incorporated in active fluvial systems bifaces behave as clasts, we must also accept that detailed evaluation of the damage they sustain as part of these active fluvial systems can inform us of how and in what manner they have been transported. This may be best achieved by taking an 'artefact biography' (Chambers in prep.) approach, where individual artefacts form the basic unit of analysis, through a return to considering the entire *état physique* of artefacts. This informs us of the damage they have sustained, while experimental data offers a means of evaluating how this damage is most likely to have occurred.

4.7 Differential abrasion development

Analysis of bifaces recovered from the gravels of the Axe River and Solent River system showed that abrasion development does not occur in a uniform manner across the entirety of an artefact (Chambers in prep). In all but the most minimally abraded examples, areas or zones of more pronounced abrasion could be identified either within a single face or in comparison of the abrasion characteristics present on each face. This prompted a re-evaluation of existing abrasion recording methodologies. It was recognised that despite the difficulties in obtaining microscopic arête abrasion values, such data provide the most reliable and repeatable means of measuring abrasion damage. Shackley's (1974) original recording technique of dividing each artefact into imaginary thirds was expanded to divide each face into six portions (Figure 138).

Whilst it is acknowledged that ideally every arête value on an abraded biface would be recorded, in the absence of scanning equipment of high enough resolution to automate this process, this was considered to be currently outside the realms of achievable data recording. Therefore two arête widths, which typify that zone of the biface, are recorded for each portion. Arête widths are recorded in a systematic manner, progressing from Zone 1 to Zone 6 for each face, generating a total of 24 arête values for each biface, a data set highly comparable to Shackley's original 25 measurements methodology. This zone-based recording technique allows areas of more pronounced abrasion damage to be identified, rather than normalised during the generation of an average abrasion value for the entire artefact as advocated by previous microscopic studies of abrasion damage.

Areas of pronounced abrasion damage can be seen on the vast majority of archaeologically abraded material so far examined from sites on the Solent River system and the River Axe, and it is postulated that these different abrasion characteristics represent different durations and types of transport.

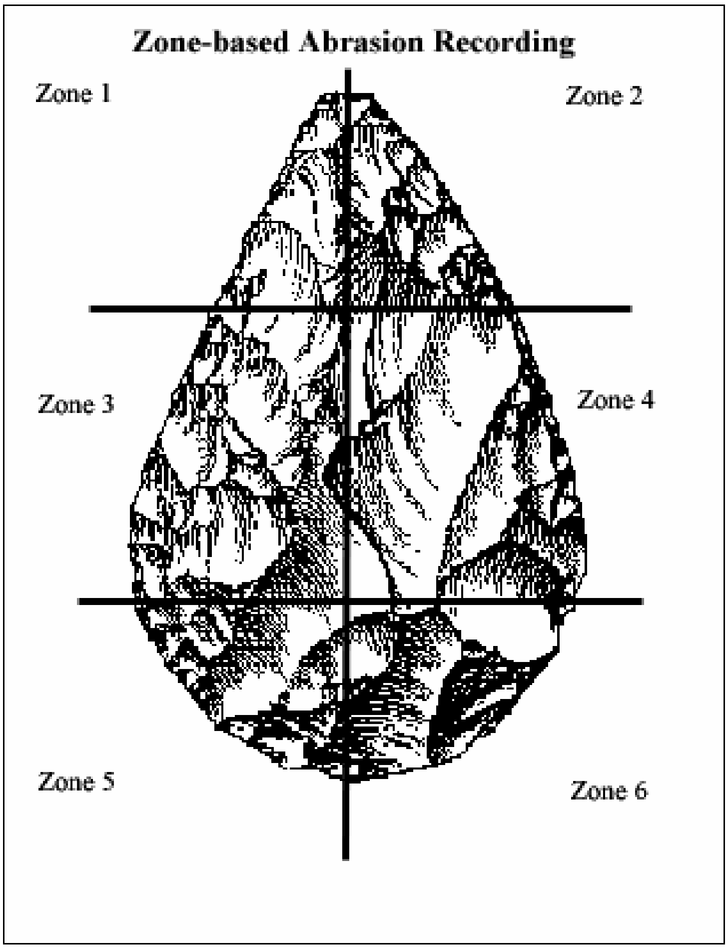

Figure 138: zone based recording of biface arête abrasion damage

4.8 Movement within fluvial contexts

Returning once again to the demonstration by Harding *et al.* (1987) that from a fluvial transportation perspective, discarded bifaces are simply clasts endowed with cultural significance, we can attempt to understand the processes and types of transportation that they have been subjected to. These attempts can be aided by a review of the extant engineering literature pertaining to particle (clast) movement within fluid systems.

Two main types of fluvially induced movement have been identified by civil and hydraulic engineering research: suspended load and bed load transport. Movement in bed load transportation regimes takes the form of types of movement that involve contact with the underlying channel bed. In contrast, suspended load transportation refers to the movement of particles within the fluid flow, without significant contact with the channel bed (e.g. Lee *et al.* 2002; van Rijn 1984).

Within the fields of both civil and hydraulic engineering the modelling of suspended load transportation remains highly problematic. Models that do exist have focused on very small (sub-millimetre particles, and require the computation of a range of variables (such as exact flow speed, water density and particle population statistics) beyond the resolution it is currently possible to determine for Pleistocene sediments.

The artefact abrasion experiments have therefore concentrated on the damage patterns that result from different types of bed load transport.

Bed load transportation can be divided into three main categories, sliding motion, rolling and saltating motion. Sliding transportation is the movement that occurs when the particle achieves movement primarily by retaining contact with the channel bed without suffering any rotation about its long axis. Movement by rolling motion also maintains a predominantly constant contact with the channel bed, though movement occurs via rotation. Saltation is defined by the Oxford English Dictionary as:

"A mode of transport of hard particles over an uneven surface in a fluid stream (as a wind or river), in which they progress in leaps, and on falling to the surface either bounce up for another leap or impart their momentum to other particles which on rising are accelerated forward by the stream"

Some researchers (e.g. Einstein 1942, 1950; Engelund & Fredsøe 1967) have sought to include saltation within the suspended modes of transport, though it is much more common for saltation to be regarded as an aspect of bed load transportation (e.g. van Rijn 1984; Lee *et al.* 2002; Nino & Garcia 1998; Lee *et al.* 2000; Sekine & Kikkawa 1992; Murphy and Hooshiari 1982), as part of the continuum of rolling/saltating motion. It should however be remembered that while two major modes of transportation have been identified these modes are not entirely distinct, but rather are connected by a region of overlap (Sekine & Kikkawa 1992).

Most bed load transport has been demonstrated to affect only the surface layers of particles within the channel bed (Einstein 1942, 1950; van Rijn 1984). Einstein (1950) calculated that the thickness of this layer was approximately twice the average particle size, van Rijn's (1984) results indicated that this layer may be up to 10 times the thickness of the average particle and that the effects of gravitational forces dominate movement.

Civil and hydraulic engineers have demonstrated that the most common type of bed load movement is that of saltation and/or rolling, with sliding motion being much less likely to occur. This pattern was found to be unaffected by flow velocity or particle size (e.g. Einstein 1942; Sekine & Kikkawa 1992; Wiberg & Smith 1985, 1989). While such studies have been undertaken on small particles, the largest being 2 cm (van Rijn 1984), the clarity and repetition of this preference for rolling and saltation merited investigation to see if archaeological materials would display similar preferences. Any trends within transportation typology could then be related to abrasion development both on experimentally and archaeologically abraded materials.

The modelling of particle movement by engineers is generally based on the recreation of an array of variables which remain unknowable for archaeological secondary context assemblages. However, the general trends such research has highlighted, such as the tendency for bed load transport to occur only in surface layers of any given channel bed, and furthermore for this bed load transport to be dominated by rolling or saltating movement can enhance the ways in which we consider modelling artefact movement in fluvial environs.

4.9 The Flume Experiments

Flume equipment provides the opportunity to recreate fluvial conditions with a greater degree of control and higher artefact recovery rates than can be maintained in real world contexts. Flume experiments evaluating the survival potential of different archaeological lithic materials have been previously undertaken, most notably in the work of Schick (1986) who charted the winnowing effects of different flow velocities on different size classes of tools and débitage. These experiments were geared towards aiding the interpretation of *in situ* knapping scatters (*ibid.*), facilitating an understanding of what *remains* at the original locations of hominid behaviour rather than an understanding of what happens to the artefacts that move. Flume experiments were also undertaken by Shackley (1974, 1975) as a key component of her investigations into abrasion measurement and artefact abrasion classification, unfortunately these data are neither published, nor included in detail as part of her PhD thesis.

Flume experiments were therefore undertaken to allow the development of transport related damage to be evaluated in conjunction with analysis of the type of movement artefacts were most likely to be subjected to (Chambers in prep). The advantage of undertaking these types of experiment under laboratory conditions, as opposed to within real fluvial contexts, are that within a glass lined flume both the type and duration of movement can be easily recorded. Variables such as flow and flume angle can be recorded and altered providing a much greater degree of control than can be achieved in real world contexts. The tendency found within engineering research for bed load transport to occur only within surface layers permitted the minimal lining of the flume with gravel, further facilitating the identification of the type of movement artefacts undertook. A flume environment was felt to be more realistic a fluvial analogue than a tumbling mill due to the ability of artefacts within the flume to engage in more extensive lateral movement than is possible within the confines of a tumbling mill.

As a link between abrasive material and arête abrasion development had been identified by Shackley (1975), it therefore also seemed probable that artefacts of different raw materials would become abraded at different rates. Replica bifaces of both fine (flint) and coarse grained (chert) raw materials were therefore prepared. Prior to the commencement of the flume experiments the metric and arête values for each artefact were recorded. The character of the artefacts edges were also recorded with regard to the degree of small flakes removed around the circumference as a direct result of knapping.

Artefacts were introduced to the gravel lined flume individually and in raw material pairs, (one ‘spinal’, one plano-convex) though for most flume runs only one artefact was included to aide the accurate recording of the transportation type. Abrasion, edge and weight loss data were recorded after set distance intervals. For the first 100m of transportation these data were recorded every 10m, between 100–200m recordings occurred after every 25m and beyond 200m data were recorded after every 50m of movement. As a result of the adoption of a zone based, systematic and repeatable arête recording methodology, each of the flume run recordings can be plotted graphically, with the abrasion development of each zone of the biface discernable and comparable. Graphic samples of the experimental data, representing the trends outlined below are shown in Figure 139–Figure 141.

The flume experiments revealed the following general trends:

- Fine- and coarse-grained raw materials develop damage at differing rates:
  - Fine-grained materials show lower initial (non-transported) arête values, and show slower arête width increase than coarse-grained materials.
  - Coarse-grained materials display higher initial (non-transported) arête values than fine-grained materials, and within the first 300–350m of fluvial transportation arête width increases quickly.
  - Once past 400m of fluvial transportation this pattern reverses itself, as the arête width increase in coarse grained material appears to stabilise and slow, whereas the arête widths on the fine grained material began to increase more quickly.
- Artefact morphology affects transportation type:
  - Bifaces with pronounced plano-convexity showed a tendency to firstly orientate themselves with their flat face in contact with the flume bed.
  - Once in this position they became orientated parallel to flow direction and were most likely to move via sliding motion.
  - Increase in flow velocity did not affect this tendency.
  - Increase in flume angle from horizontal to up to -10° increased the likelihood of sliding motion, flat face down, in plano-convex bifaces.
  - Bifaces without plano-convexity (referred to as ‘spinal’ bifaces) showed a tendency to orientate themselves perpendicular to flow direction, with no facial preference.
  - Once in this position they were most likely to move via rolling or saltating motion
  - Increase in flow velocity did not affect this tendency.
  - Increase in flume angle from horizontal to up to -10° did not affect this tendency.
  - This pattern of morphological governed movement occurs in both fine and coarse-grained raw materials.

- Transportation type affects the damage sustained:
  - Bifaces that have moved via rolling or saltating sustain arête damage that is highly variable within a single face.
  - The thickest parts of the biface are more likely to become most heavily abraded.
  - While the individual arête widths on a single face may be variable, when the range and distribution of arête widths of each face is considered against that of the other face general consistency can be demonstrated. Due to the systematic, zone-based arête recording technique, the abrasion signature of each face can be plotted and compared (Figure 139 & Figure 140).
  - Bifaces that have moved via rolling or saltation are more prone to sustain edge damage in the form of small flake removals (referred to as 'micro-flaking'). Micro-flaking intensity increases with transportation distance.
  - Plano-convex bifaces, moved by sliding, show more consistent arête width values to their flat face, the result of grinding of the arêtes as they slide over the flume (channel) bed.
  - The convex face of plano-convex bifaces moved by sliding motion can show variable arête widths, the result of clast bombardment. This abrasion signature can also be plotted and compared (Figure 141).
  - Bifaces that have moved via sliding motion are unlikely to sustain discernable quantities of micro-flaking.

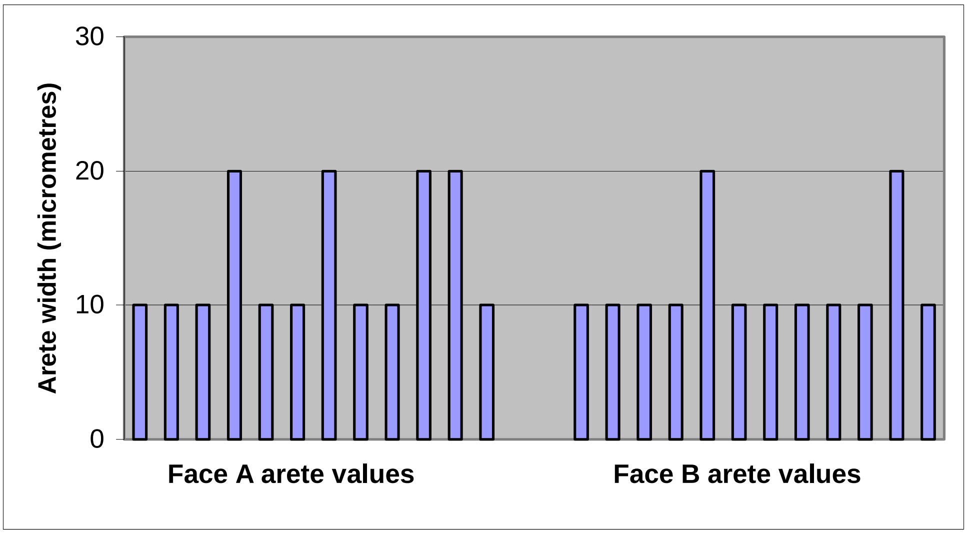

Figure 139: Sample experimental saltation abrasion data ('spinal' flint biface after 10m saltation (no edge damage). After minimal transportation, arête values within a single face can be seen to vary, though comparison of the general abrasion pattern of both faces shows consistency

The experiments have generated a large data set pertaining to the abrasion (and edge damage) development of both fine and coarse grained raw materials under the most common modes of bed load transportation. These data demonstrate that the dominant transportation regime influences the damage that artefacts sustain. Artefacts of different raw materials abrade at different rates, but appear to show similar general damage development patterns. Artefact morphology is also a significant factor in abrasion development as only plano-convex artefacts showed an inclination towards sustained sliding motion.

This data set can be used in comparisons with archaeologically abraded artefacts, providing a means with which to evaluate the most probable transportation regime and the distances they have been subjected to.

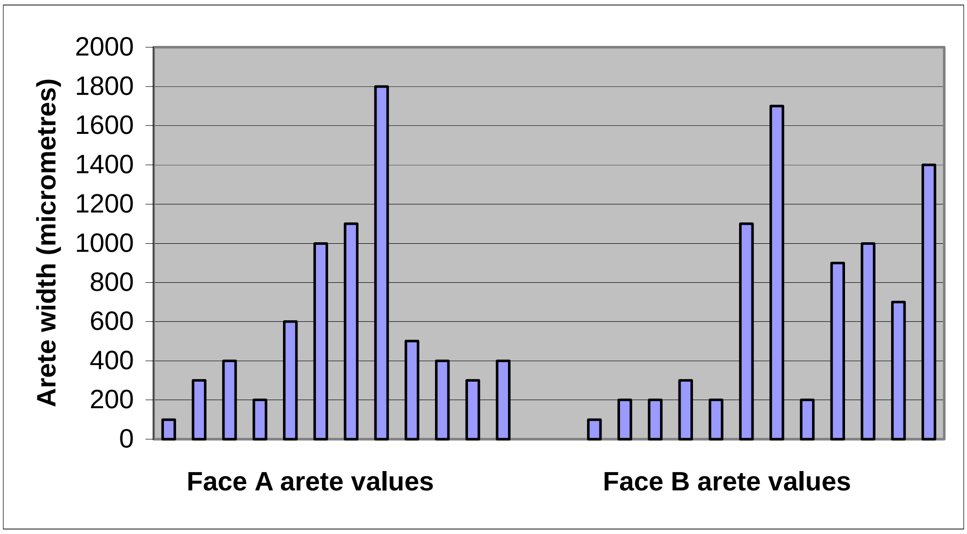

Figure 140: Sample experimental abrasion data ('spinal' flint biface after 500m saltation (moderate edge damage). After 500m of predominantly saltation movement, the variability within each face has increased, but the inter-face consistency remains.

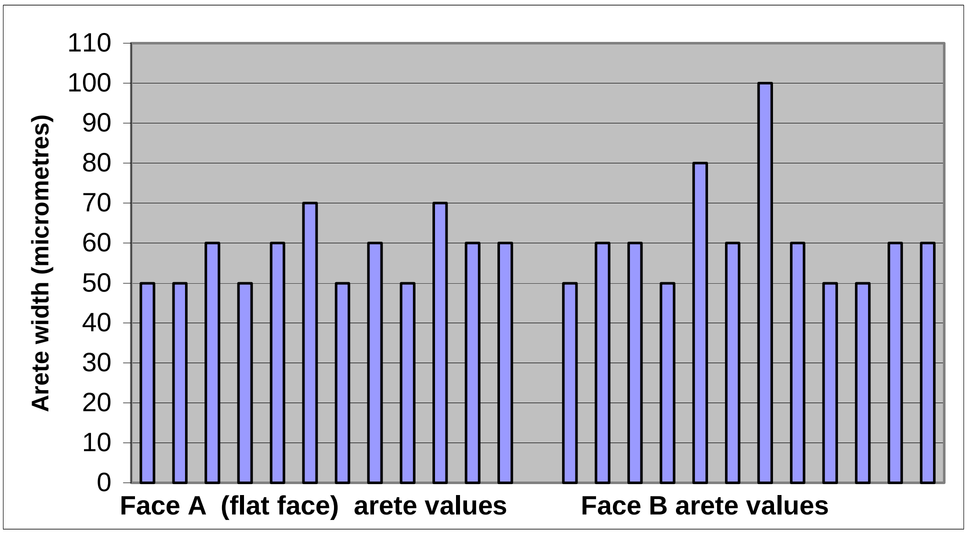

Figure 141: Sample experimental abrasion data (chert plano-convex biface after 100m sliding (no edge damage). After 100m of predominantly sliding motion on the flat face (Face A), the consistency of arête widths on this face can be seen, in comparison to the more variable pattern displayed by the 'spinal' face (Face B)

4.10 Archaeological applications of flume data

The experimental data set generated by the flume transportation of different raw material and morphological forms of biface, provide a basis with which to more meaningfully evaluate archaeologically abraded bifaces than can be achieved using extant techniques (e.g. Wymer 1968; Shackley 1975; Hosfield 1999), as they inform us not only of relative degrees of transportation but also transportation type and duration. They have also highlighted the need to evaluate the entirety of individual artefact's *état physique*, not only the arête widths when considering fluvial transportation damage. There are however shortcomings within the dataset. It was not possible to model the damage sustained by artefacts that have not themselves been moved, but that become entrained and are subsequently bombarded by smaller (and therefore mobile) clasts or silt. Neither has it been possible to evaluate the damage sustained during suspended mode transportation. It is acknowledged that during Pleistocene conditions flow velocity was probably high enough for fluvial particles the size of bifaces to enter into suspended flow at specific times.

As it is anticipated that the damage sustained in such conditions would largely depend on the size and velocity of other suspended particles (data not readily available for many secondary context archaeological assemblages) it is felt the current geomorphological, archaeological and engineering models do not yet lend themselves to the generation of appropriate experimental models. Therefore the value of the bed load transportation model data created in the flume experiments described above lies in its ability to provide a *minimum* transportation distance dataset to which archaeologically abraded data can be compared.

A flow chart for the comparison of archaeologically abraded material to the experimental data set is shown in Figure 142. Prior to comparison, artefact abrasion data should be recorded in the zone based manner outline in Section 4.7 and Figure 138, which facilitates an understanding of where each arête value has been recorded on the biface and then identification of correlations with the experimental data set.

Once archaeological abrasion has been recorded in a zone based manner, the patterns of damage preserved on each face can be evaluated. The simplest way to represent this data has proved to be in the form of bar charts (e.g. Figure 139–Figure 141), as this allows easy distinction between the two main forms of abrasion damage (intra-face zonal variability with inter-face consistency (Figure 139) or intra-face consistency on a single face and intra-face variability on the other (Figure 141).

As the flume experiments have shown only bifaces that display marked plano-convexity are likely to have moved substantial distances via sliding motion, the next stage in correlating the experimental and archaeological abrasion and damage data is to assess the plano-convexity of the archaeological artefact.

Plano-convex artefacts are next checked for edge damage in the form of micro flaking to parts of, or all, of their circumference. If the artefact has been subjected to sliding alone, then little or no edge damage will have developed and the arête damage sustained can be directly correlated with the sliding experimental data of the appropriate raw material type. If small quantities of edge damage are present then minimal amounts of rolling or saltating movement have occurred, but the dominant form of transport will have been sliding as represented by the relative consistency of the arête widths of the flat face. Such artefacts can also be directly compared to the experimental sliding data. If a plano-convex artefact shows substantial amounts of edge damage then it is unlikely to have been moved primarily by sliding motion, as it is the edge impacts that happen during rolling and/or saltation which cause the removal of small flakes from the edges of artefacts. Such artefacts can therefore be cautiously correlated with the saltation experimental data set.

The pattern of intra-face consistency of arête widths on one face and intra-face variability on the other can occasionally be seen on non plano-convex archaeological artefacts. If such artefacts also display edge damage (the result of rolling and/or saltation) then they can be considered to have been primarily transported via these means and can also therefore be cautiously correlated with the saltation experimental data set. If they do not show edge damage then they are unlikely to have rolled or saltated very far. The most plausible scenario for the development of such a damage signature is that the artefact has not moved very far as part of a bed-load movement regime. It is more likely to have become partly buried or entrained somewhere within the fluvial system and has suffered from extensive clast bombardment, by smaller, more mobile particles. It is also possible that this damage signature may result from prolonged burial within silts, unfortunately no experimental data set currently exists for such a scenario.

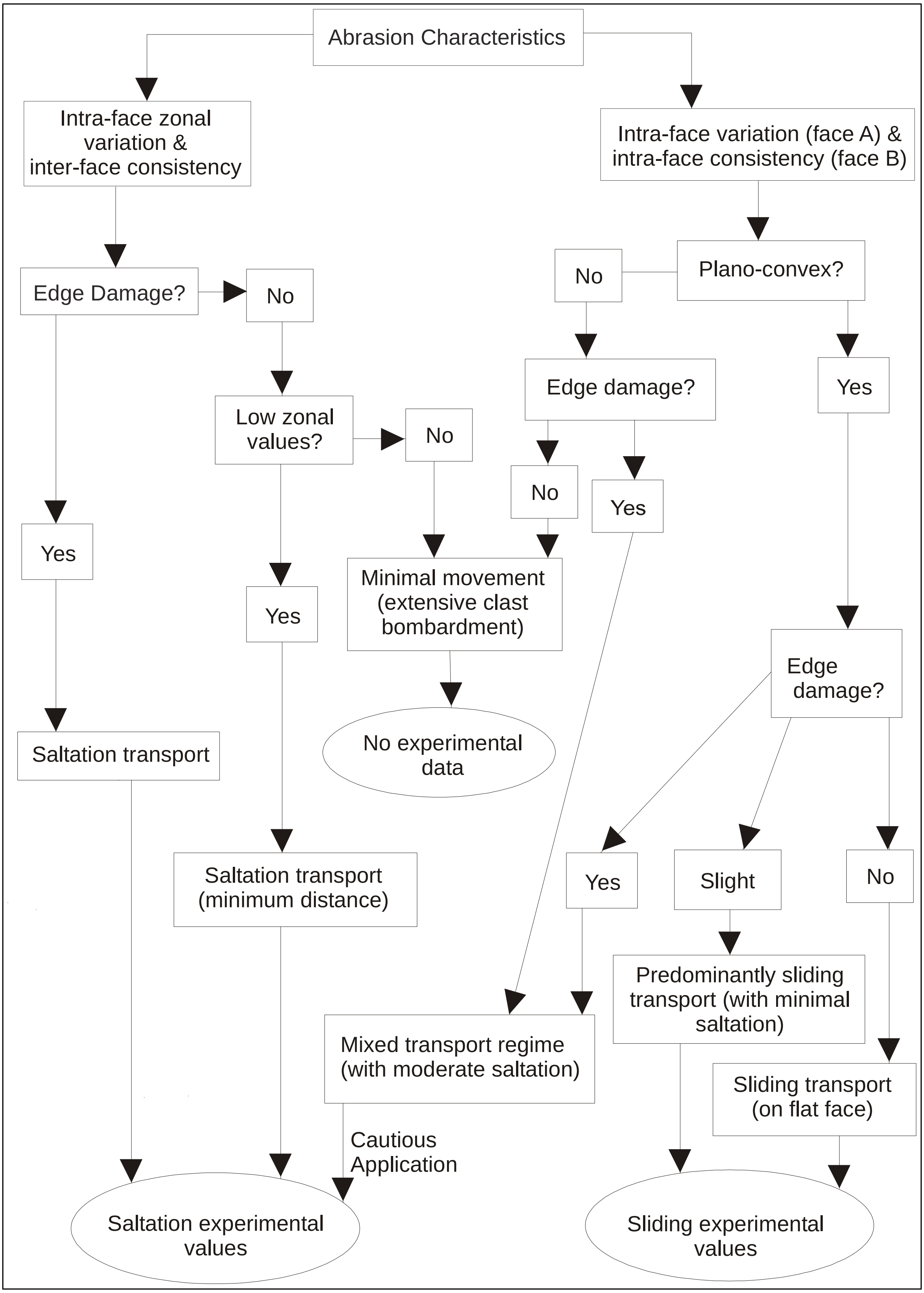

Figure 142: interpretation of artefact transportation from abrasion and biface morphology data

The abrasion signature of intra-face zonal variation and inter-face consistency is most commonly an indicator of rolling and/or saltation motion. If graphic representation of archaeological bifaces reveals this pattern of abrasion damage, once again the next stage in correlation is the assessment of edge damage. If the biface shows the development of edge damage, then it is mostly likely to have been primarily transported by rolling or saltation and can be compared to the saltation experimental data set of the appropriate raw material. If the biface displays the intra-face zonal variation and inter-face consistency indicative of rolling and saltation motion but no edge damage then several transportation scenarios present themselves. If the arête values (zonal values in the flow chart) are low then it is likely that the artefact has rolled or saltated, but not for very great distances. Such bifaces can be compared to the lower end of the experimental saltation data set of the appropriate raw material. If the arête widths are large then it is unlikely that the biface could have rolled or saltated the distances implied by the arête damage without sustaining micro flaking to its edges. Such a damage signature is indicative of minimal artefact movement, combined with large quantities of clast bombardment or silt coverage during periods of partial burial. No experimental data set exists for this scenario.

4.11 Fluvial transportation of the Broom assemblage

The Broom artefacts are manufactured on both flint and chert. Most of the bifaces have been made on locally available greensand chert. Greensand chert is a highly variable raw material and each artefact has been classified in this analysis as falling into one of three categories (fine-, medium- and coarse-grained) based on a visual assessment of grain size. Fine-grained chert has been considered to sustain abrasion damage in a similar manner to flint, and bifaces of fine-grained chert are modelled against the flint experimental data set. Coarse-grained chert replica bifaces were incorporated within the flume experiments and have their own data set for experimental and archaeological comparisons. Many of the Broom bifaces are manufactured on medium-grained chert blanks. An experimental medium-grained abrasion development data set has been created, through correlation with the extant fine- and coarse-grained experimental data. It is assumed that medium grained chert will abrade in a rate intermediate to that of fine and coarse grained materials.

The following discussion illustrates the correlation of experimental and archaeological abrasion data with an example from the Broom biface assemblage (Figure 143). Biface 210 (Bean collection) is made of coarse-grained chert and was therefore compared to the experimental coarse-grained chert data sets (saltation and sliding). The biface is not plano-convex and examination of the artefact's edges showed a moderate amount of edge damage in the form of micro-flaking (Figure 144). The arête signature of biface 210 (Figure 145) was therefore compared with the saltation data set, rather than the sliding data, and was fond to correlate with 200m, saltation signature for a coarse-grained biface (Figure 143).

It can be seen that though these data are highly comparable they do not correlate exactly. The nature of the application of this data is such, that comparisons are made to the experimental data and a 'best fit' scenario adopted. It is postulated that the observed minor variation reflects the episodic nature of fluvial transportation, perhaps representing small sliding events or episodes of partial burial, within the overall saltating regime.

Each Broom biface was compared to the appropriate raw material and transportation experimental data set, as outlined in Section 4.10 and illustrated above. The Broom biface abrasion data is included on the accompanying CD (see the text file 'readme.txt' and the database file 'Bean Collection Database_EHCopy.mdb). The experimental data set is included in J. Chambers' PhD thesis (submitted to the University of Southampton and currently awaiting examination; Chambers in prep.). These results of the Broom biface analysis and distance modelling are firstly presented in terms of distance transported, irrespective of the type of movement identified (Figure 137).

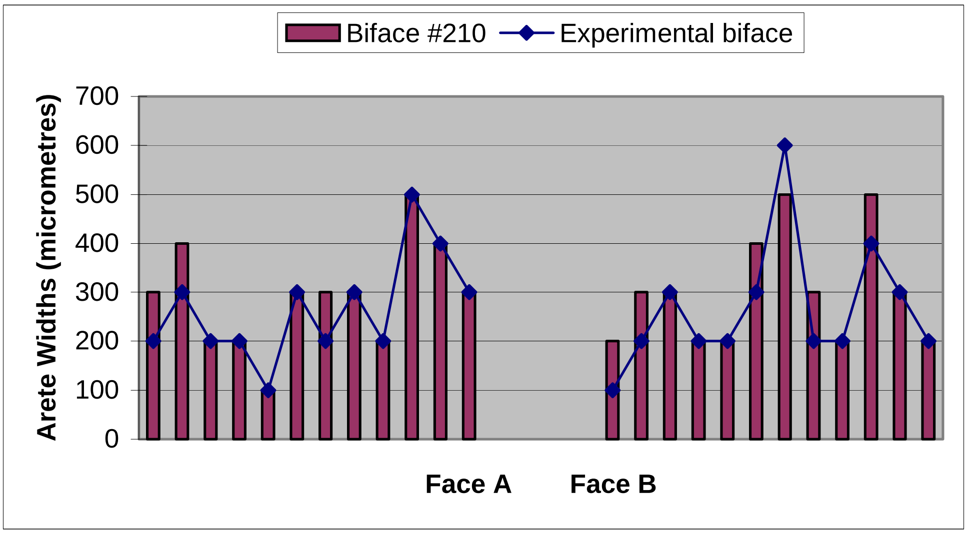

Figure 143: comparison of experimental (coarse-grained chert biface, saltation, 200m) and archaeological (Broom biface 210) abrasion data

Figure 144: Broom biface #210, including edge micro-flaking

Consideration of the transportation data preserved on the entire biface sample (Figure 137) clearly shows that the majority of the artefacts have probably travelled less than 300m from their original point of discard. Constraints of the experimental data set inhibit the specific modelling of distances beyond one kilometre, however this can be seen to represent a very small percentage of the assemblage. These results would seem to indicate the Broom assemblage has a relatively small main spatial catchment area, that most artefacts have only been reworked over distances of several hundred metres rather than for many kilometres. This has significant implications for the ways we view the preserved evidence of hominid landscape behaviour (Section 6).

This data would appear to support the assertion that the large assemblage of artefacts within the river gravels at Broom have not travelled *far* from their original point of discard in the Axe Valley landscape. It is also interesting to note that none of the examined bifaces appear to have been fluvially transported distances of less than 50m, so while the Broom bifaces can generally be regarded as being of relatively local origin, the spatial interpretation of their abrasion damage would indicate that they have all moved beyond any acceptable definition of *in situ.* It is also worth reiterating that this modelling is based on the experimental reproduction of damage sustained during bed load transportation, it is entirely possible that the distance data generated is a substantial under estimation, as many of these artefacts may also have been moved as suspended load within periods of high energy fluvial activity.

When the assemblage is considered in terms of the type of transportation undertaken, it can be seen that saltation is by far the most common mode of movement (Figure 146) The dominance of saltated bifaces reflects both the propensity for particles (be they clasts or artefacts) to move in this manner identified by engineering research (e.g. Einstein 1942), and the relative scarcity of plano-convex artefacts within the Broom assemblage (22%, n=142).

Figure 145: Broom biface #210 (face B), including arêtes

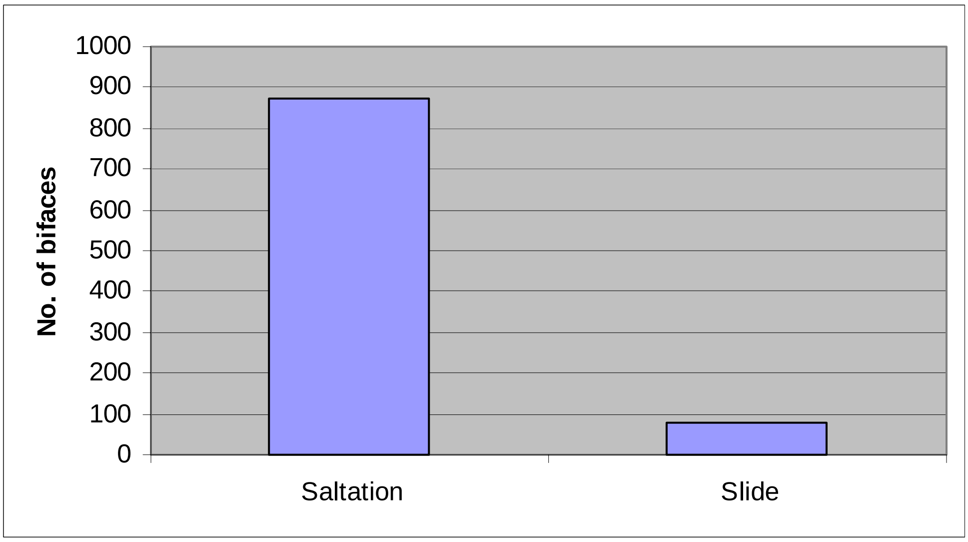

Figure 146: occurrences of saltation and sliding movement within the Broom biface assemblage

The component of the Broom biface assemblage that shows evidence of transportation via saltation (Figure 147), mirrors the pattern of movement seen in the entire sample. The majority of the sample has been transported approximately 250m, with less than 3% of the sample (22/872) showing evidence of fluvial transportation distances of more than one kilometre. The transportation distances appear to be broadly unaffected by artefact type, raw material type, artefact shape, thickness or refinement (Section 6).

As described above, the number of bifaces which show evidence of moving through sliding motion is small. The sliding distances presented in Figure 148 once again show the predominance of artefacts transported for approximately 200–300m.

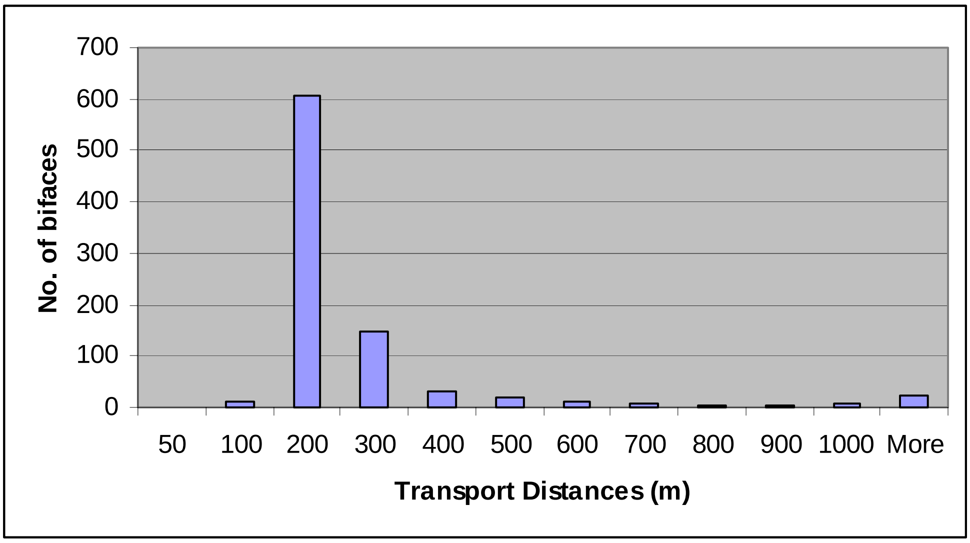

Figure 147: Broom bifaces transported by saltation (class interval = 100m)

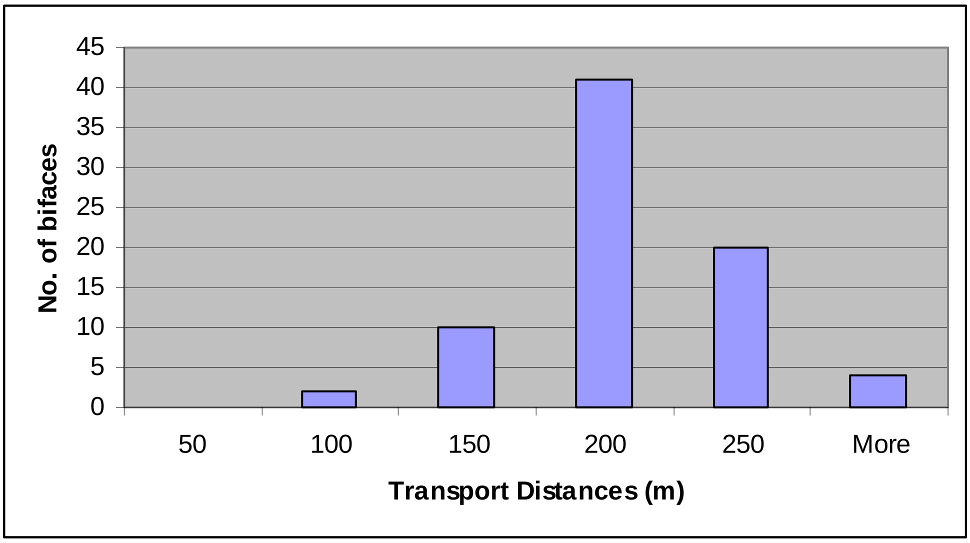

Figure 148: Broom bifaces transported by sliding (class interval = 100m)

To summarize, the comparison of the transportation evidence preserved in the examined sample of Broom bifaces against the data generated by flume experiments is indicative of a relatively local accumulation of artefacts from within 200–300m. No artefacts appear to have been transported less than 50m, and only a very small percentage of the entire sample can be demonstrated to have been fluvially transported over a kilometre. It is possible that these highly transported bifaces have been fluvially re-worked from older terrace deposits in upstream areas of the Axe valley, though provenancing and archive quality prohibit confirmation of this hypothesis.

5. STRATIGRAPHIC ORIGINS OF THE ASSEMBLAGES

One of the key aims of this module was to test whether the Broom assemblage is essentially homogeneous, or whether it is a mixed palimpsest formed of a series of smaller, heterogeneous samples. This question was addressed by sub-dividing the assemblages into spatial sub-units (Section 4) and stratigraphic sub-units (this section). The division of the assemblage into stratigraphic sub-units sought to test whether:

1. There were significant differences in the typological composition of the biface component in each of the sub-units.
2. There were significant differences in the technological aspects (e.g. raw material type and form) of the biface component in each of the sub-units.

The stratigraphic sub-division was based on the tripartite sedimentary sequence at Broom (lower gravels–middle beds–upper gravels), the datum level documented by C.E. Bean at c. 49m OD, and those artefacts for which a stratigraphic level (relative to the datum) was recorded by C.E. Bean. Green (1988: Table 2) suggested four categories of artefact levels (datum ±1m; below datum -1m; below datum; above datum), into which he fitted 109 bifaces, 27 flakes and 6 other artefacts. A similar classification was undertaken here, based on the current biface sample (977 bifaces) and a re-analysis of the Bean archive. Three categories were suggested: above datum (22 bifaces, Table 40); datum level ±1m (72 bifaces, Table 41); and below datum (52 bifaces, Table 42). The datum level ±1m is argued to broadly lie at the elevation of the middle beds, although there is inevitably some local variation.

Biface number	Description
23	5 ft above road level
66	6 ft above datum
76, 77, 85	From surface at back of pit
79	4 ft above the cracker level (approximately equal to the 1st floor level)
100	Above datum
107	1st floor + 0–5 ft
158	23 ft above datum
265	Above 1st floor level
371, 372, 374	15 ft above 1st floor level
386	Near surface at back of pit
493	From top 4 ft of gravel
787	Found at top of pit in sand bed
796, 797, 798, 799, 800, 801	From higher levels of pit (probably above datum)

Table 40: biface numbers and stratigraphic descriptions for the above datum sub-sample

Biface number	Description
1, 20, 29, 31	About 30 ft deep
7	Red bed about 30 ft deep = 2 ft above road level at end of cottage
12	Cottage gate level or upto 6 ft below
49, 53, 64, 68, 99, 108, 237, 246, 264, 537	Datum level
82, 84	About 30' deep (approximately equal to the datum level)
86, 227, 951	1st floor level
90	Road level opposite cottage
183	Datum ±1 ft
6, 35, 87, 118, 120, 121, 125, 127, 128, 130, 135, 139, 142, 159, 161, 162, 164, 165, 166, 167, 169, 170, 171, 172, 173, 174, 177, 189, 191, 192, 194, 195, 594	Datum ±2 ft
85, 190/2, 208	Datum -2 ft
18, 93, 238, 240	Datum ±3 ft
115, 132, 232, 233, 234, 235, 236, 241	Datum -3 ft
131	Datum ±4 ft

Table 41: biface numbers and stratigraphic descriptions for the datum sub-sample

Biface number	Description
4	Upto 6 ft below cottage gate level
5	8 ft below the road on the southwest side of the cottage
10, 656	Lowest portion of pit (heights based on dates of artefact recovery)
17	Bottom of pit in sand bed
24	Clay bed below 1st floor
58, 96, 126, 134, 136	Below datum
122, 137, 336, 388, 512, 514, 515, 517, 518, 519, 520, 521, 522, 524, 525, 526, 529, 530, 531	Below the 1st floor level
113, 229	Lower level at back of pit
153, 242	4 ft below datum
203, 209, 210, 217	5 ft below datum
116	5–10 ft below datum
469, 471, 473, 474, 475, 476, 478, 479, 480, 481, 482, 484	0–20 ft below datum
103	50 ft deep 'Red Bed'

Table 42: biface numbers and stratigraphic descriptions for the below datum sub-sample

This stratigraphic sub-division obviously makes the assumption that the three units and their contained artefacts are chronologically distinct. The OSL dates for the Broom sediments do not provide an absolute geochronology for the intervals between the three units, but samples GL02083–85, GL03004, GL03006–7 and GL03010 suggest that the interval between the middle beds and the upper gravels may be at least 20,000 years. It should be stressed of course, that there are essentially two models for the supply of artefacts into the fluvial sediments that accumulated at Broom:

1. Over a series of chronologically distinct events, artefacts are discarded onto the floodplain (either upstream or at Broom) and rapidly incorporated into the accreting fluvial sediments — i.e. the artefacts are broadly contemporary with their sedimentary context (within ±10's of years) and the artefacts from each chronologically distinct event are not contemporary with each other.
2. Artefacts are discarded onto the floodplain and subsequently buried into the deposits. Subsequent migration of the River Axe across its floodplain leads to the gradual release of material into the fluvial system and their gradual deposition within the accreting sedimentary sequence — i.e. the artefacts are not contemporary within their final sedimentary context, but are contemporary with each other.

An assessment of these alternative models is given in the following chapter, and is also discussed in terms of the stone tool assemblages in the conclusion at the end of this chapter.

Comparison of the typological and technological characteristics of the three sub-units indicates little significant variation, either from each other, or the overall assemblage pattern (Section 3). However, it should be stressed that the small sample sizes create difficulties in detecting subtle trends, and that these comparisons are therefore based upon general patterns. The above datum sub-sample showed clear similarities with the overall assemblage:

- Biface typology is dominated by cordate/ovate forms (40%, n=9), with a combination of ovates, cordates, points and sub-cordates making up the remainder. There is a single cleaver, but no ficrons or flat-butted cordates. The cordate/ovate types also dominated the asymmetrical (lop-sided) and plano-convex biface sub-samples.
- Blank forms (Figure 155) were predominantly unidentified (68%, n=15), although those that were positively identified indicated a mixture of cobbles (57%, n=4) and flakes (43%, n=3).
- Raw material types (Figure 156) were dominated by medium-grained chert (45%, n=10), with small quantities of fine (27%, n=6) and coarse-grained chert (22%, n=5) and flint (5%, n=1).
- Tip types are dominated by irregular rounded (32%, n=7), rounded (14%, n=3) and ogee points (14%, n=3), although the previous comments regarding potential damage and alteration of biface tips during fluvial transport should be recalled. There is a single example of a tranchet tip.
- Butt types (Figure 157) were dominated by trimmed flat (45%, n=10) and trimmed (32%, n=7) types.
- Biface weight (Figure 149) was clustered between 300g and 500g (60%, n=12), with a total weight range of 1113g.
- Biface edges (Figure 158) were dominated by straight and sinuous profiles (95%, n=19), with the sample sub-dividing as follows: straight/sinuous edges (41%, n=9); double straight edges (36%, n=8); and double sinuous edges (18%, n=4). In the case of asymmetrical (lop-sided) bifaces the sample size is unfortunately far too small (n=4) to discuss any further comments.
- Bifaces were concentrated in the 100–300m abrasion categories (70%, n=14), with a scattering of more heavily abraded examples (Figure 150).

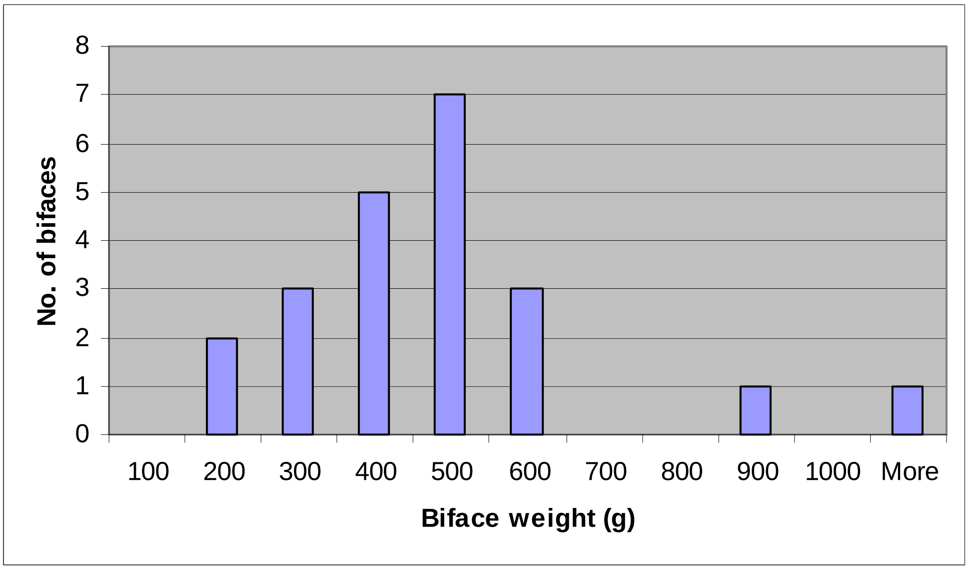

Figure 149: biface weight distribution (above datum sample)

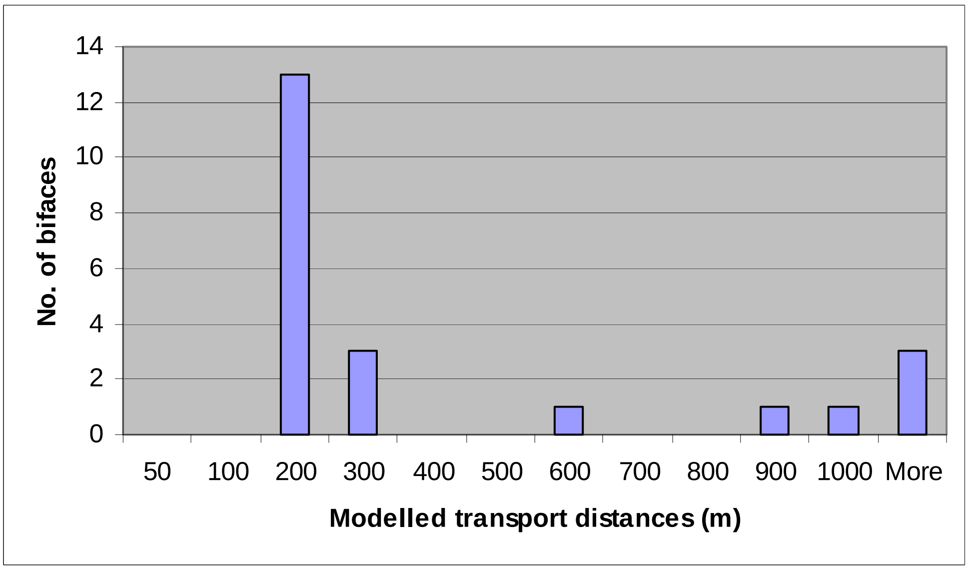

Figure 150: biface transport distances (modelled) distribution (above datum sample)

The datum sub-sample also showed clear similarities, with both the overall assemblage and the other sub-samples:

- Biface typology is dominated by cordates (35%, n=25), with smaller numbers of ovates, cordates, sub-cordates, points and transitional forms. Although the dominant category (cordates (Wymer type J) differs from the other samples and overall assemblage (cordate/ovates (Wymer type JK), it is suggested here that this difference is of relatively minor importance, particularly as cordate/ovates (14%, n=10) are the joint second largest category in this sample. Cleavers, ficrons and flat-butted cordates were all present in this sample in very small numbers. The cordate forms (75%, n=12) also dominated the asymmetrical (lop-sided) forms, with the remainder of these forms consisting of cordate/ovate (n=3) and pointed/ficron (n=1) types. The plano-convex biface forms consisted of a mixture of a mixture of types, although it is perhaps noticeable that this sub-sample contains 4 pointed/ficron forms (21%).
- Blank forms (Figure 155) were predominantly unidentified (67%, n=48), although those that were positively identified indicated a mixture of cobbles (33%, n=8) and flakes (46%, n=11).

- Raw material types (Figure 156) were dominated by medium-grained chert (47%, n=34), with smaller quantities of fine- (25%, n=18) and coarse-grained chert (19%, n=14) and flint (8%, n=6).
- Tip types are dominated by irregular rounded (38%, n=27), ogee (15%, n=11) and rounded points (13%, n=9), although the previous comments regarding potential damage and alteration of biface tips during fluvial transport should be recalled. There are no examples of tranchet tips.
- Butt types (Figure 157) were dominated by trimmed flat (58%, n=42), although there was a notable presence of part trimmed/part cortex butts (16%, n=12) and trimmed (15%, n=11) types.
- Biface weight (Figure 151) was clustered between 100g and 500g (75%, n=54), with a total weight range of 1288g.
- Biface edges (Figure 158) were dominated by straight and sinuous profiles (97%, n=70), with the sample sub-dividing as follows: double straight edges (58%, n=42); straight/sinuous edges (26%, n=19); and double sinuous edges (13%, n=9). This overall pattern is replicated on asymmetrical (lop-sided) bifaces: double straight edges (50%, n=8); straight/sinuous edges (38%, n=6); and double sinuous edges (13%, n=2).
- Bifaces were concentrated in the 100–300m abrasion categories (88%, n=63), with a scattering of more heavily abraded examples (Figure 152).

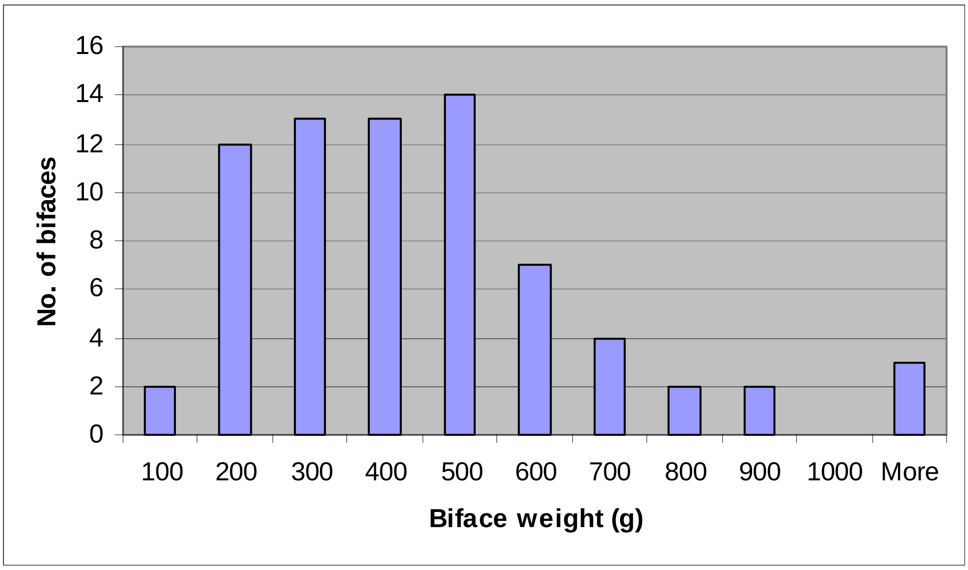

Figure 151: biface weight distribution (datum sample)

The below datum sub-sample also showed clear similarities, with both the overall assemblage and the other sub-samples:

- Biface typology dominated by cordate/ovate (31%, n=16) and cordate (23%, n=12) forms, with a combination of ovates, points and sub-cordates making up the bulk of the remainder. There is are 2 cleavers and a single ficron, but no flat-butted cordates. The cordate/ovate types also dominated the asymmetrical (lop-sided) bifaces, while the plano-convex bifaces were a mixture of cordate, cordate/ovate, sub-cordate and ovate types.
- Blank forms (Figure 155) were predominantly unidentified (63%, n=33), although those that were positively identified indicated a mixture of cobbles (26%, n=5) and flakes (63%, n=12).
- Raw material types (Figure 156) were dominated by medium-grained chert (44%, n=23), with smaller quantities of fine (25%, n=13) and coarse-grained chert (19%, n=10) and flint (10%, n=5).
- Butt types (Figure 157) were dominated by trimmed flat (54%, n=28) and trimmed (25%, n=13) types.
- Biface edges (Figure 158) were dominated by straight and sinuous profiles (92%, n=48), with the sample sub-dividing as follows: double straight edges (37%, n=19); straight/sinuous edges (31%,

n=16); and double sinuous edges (25%, n=13). This overall ordering is replicated on asymmetrical (lop-sided) bifaces, although the sample size is too small (n=10) to make any further comments.
- Bifaces were heavily concentrated in the 100–300m abrasion categories (96%, n=48; Figure 153).

However, the 'below' datum sample also indicated a minor contrast with respect to tip types and biface weight:

- Although tip types are still dominated by irregular rounded forms (38%, n=20), there is also a significant proportion of irregular pointed types (21%, n=11). These are very uncommon in the other sub-units, and also in the overall assemblage (6%, n=60). However, the previous comments regarding potential damage and alteration of biface tips during fluvial transport should be recalled. There are no examples of tranchet tips.
- Biface weight was clustered between 200g and 600g (62%, n=32), with a total weight range of 653g (Figure 154). The relative small weight range might suggest a greater imposition of 'standardisation' or consistency with respect to biface size (as measured by weight). However, caution should be applied here, since the role of clast size (taking the biface as an unusually shaped clast) may have been extremely important with respect to patterns of transport and deposition during the accumulation of the Broom sediments.

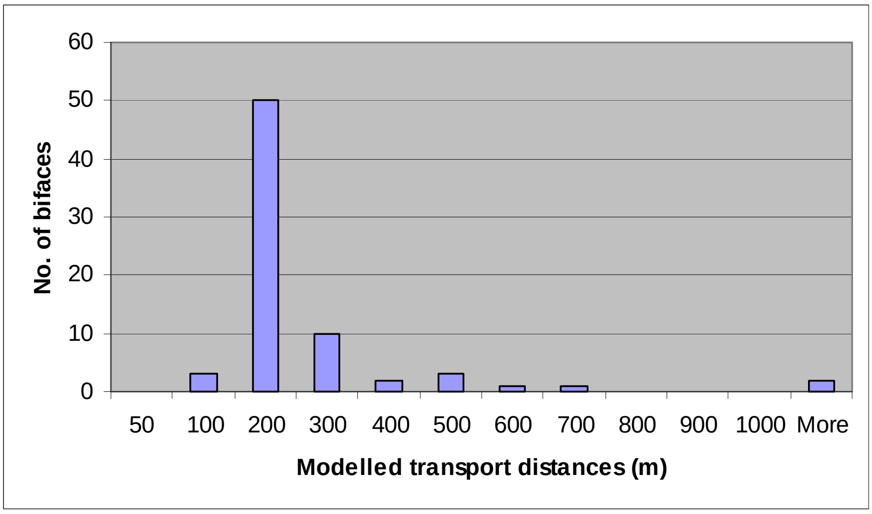

Figure 152: biface transport distances (modelled) distribution (datum sample)

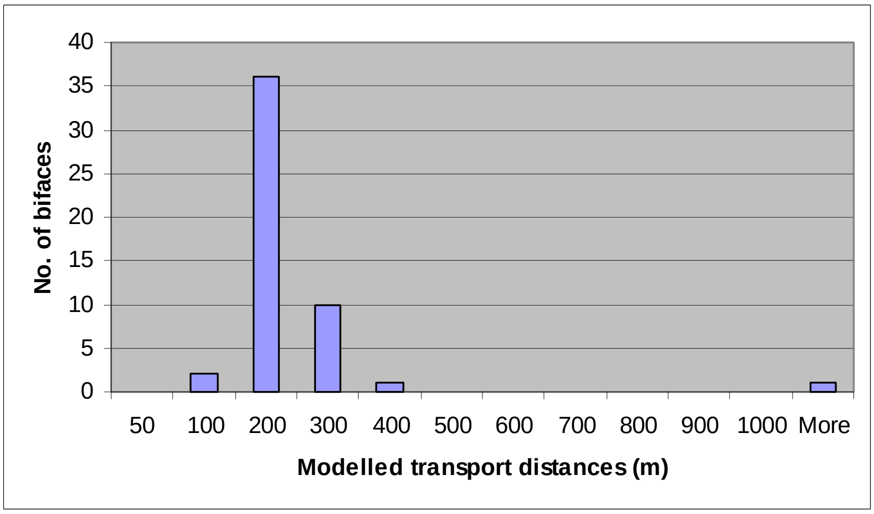

Figure 153: biface transport distances (modelled) distribution (below datum sample)

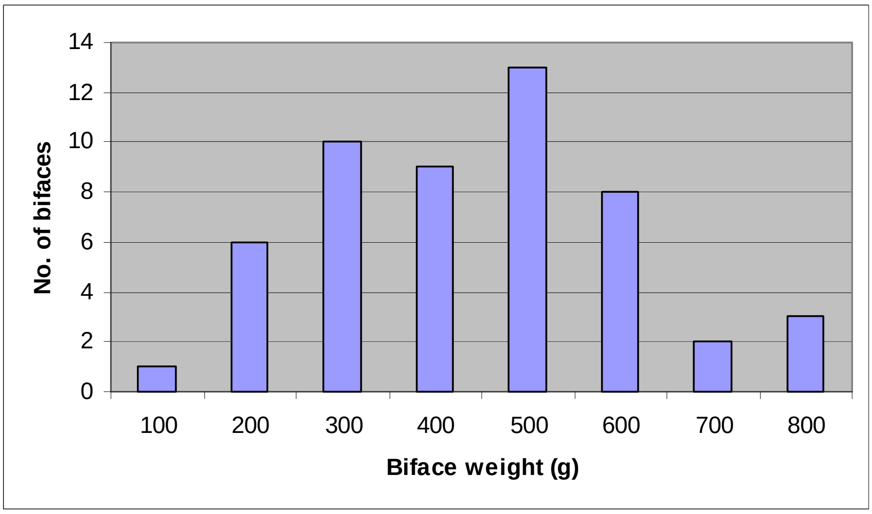

Figure 154: biface weight distribution (below datum sample)

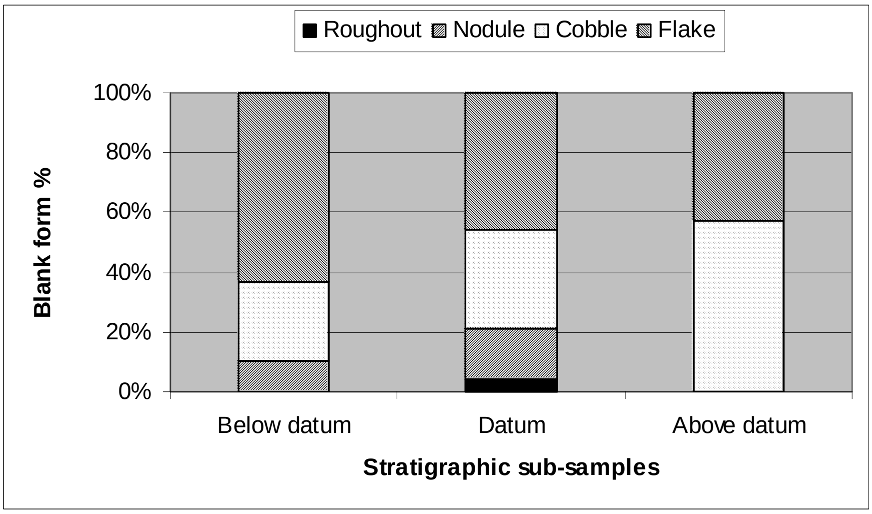

Figure 155: blank form distribution, by stratigraphic sub-sample

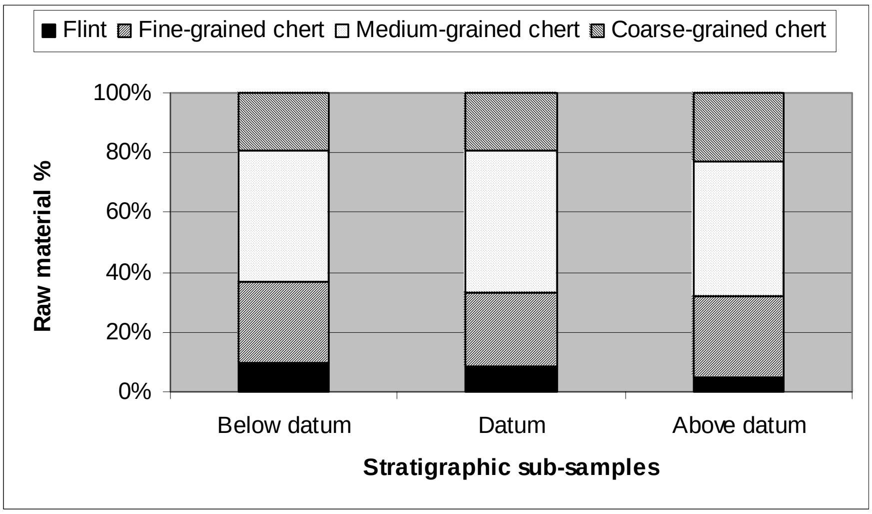

Figure 156: raw material distribution, by stratigraphic sub-sample

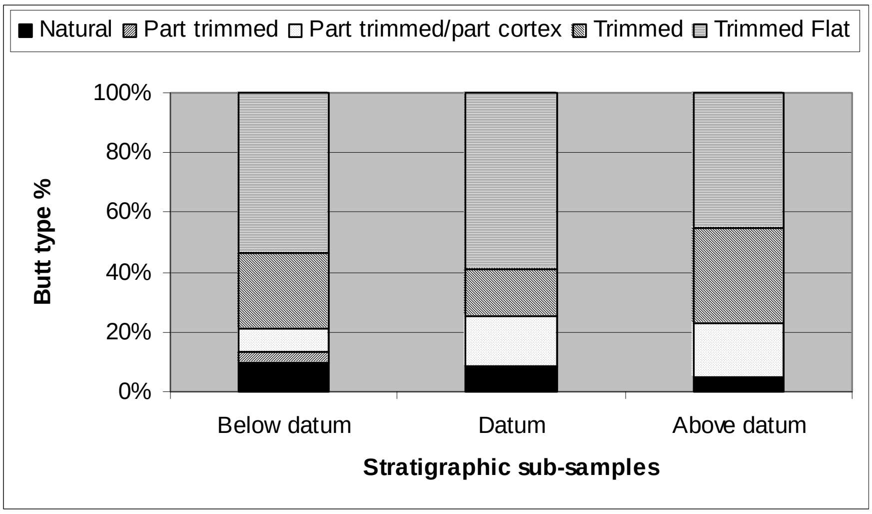

Figure 157: butt type distribution, by stratigraphic sub-sample

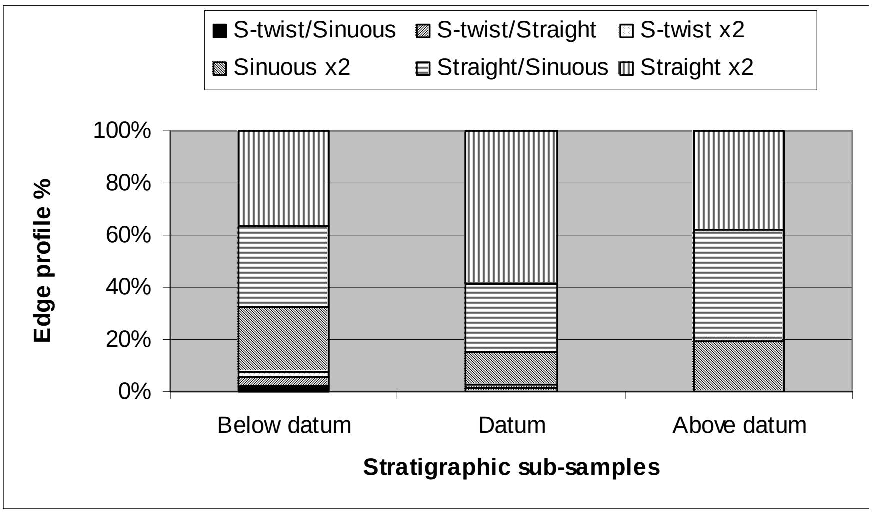

Figure 158: edge profile distribution, by stratigraphic sub-sample

The patterns evident in the three sub-samples suggest that there are no significant changes in the typological and technological composition of the biface assemblages through time (following the assumption that the three sub-samples are chronologically distinct with respect to their stratigraphic position within the sedimentary sequence). Specifically, the following points are stressed:

1. There are no major changes in the patterns of bifaces types (predominantly cordate/ovate forms), raw material usage (primarily medium-grained chert), blank forms (cobbles and flakes — although the sample sizes are rather small to place much emphasis on these patterns, particularly given the problems of positive identification of blank forms), tip types (irregular rounded — but recall comments regarding fluvial damage to biface tips), butt types (trimmed flat and trimmed types) and edge types (straight and sinuous profiles) throughout the sedimentary sequence.
2. The low level usage of flint in all three samples suggests that this raw material was never abundantly available from the local environment at any point (this obviously assumes that flint would have been a preferred material when 'easily' obtainable, and it is possible that flint may not have been highly sought after, as knapping experiments (by JCC) have indicated that fine-grained chert materials possess a similar range of flaking properties.
3. None of the artefacts are in 'mint' condition and all suggest some degree of fluvial transportation. The below datum sample suggests the greatest spatial homogeneity, with a probable local catchment source indicated (within 200–300m of the Broom sediments?). This pattern is also

replicated in the other samples, although there is more evidence of 'stray' artefacts derived over greater distances in these samples.

4. Smaller artefacts (as measured by weight) were more common in the datum sample, while the below datum sample was characterised by a narrower range of biface weights. These patterns may reflect taphonomic processes (flow energy), the quality and/or size of available raw materials, or short-lived hominid preferences for bifaces of a particular size. Given the general absence of variation and patterning in the assemblage, the taphonomic hypothesis is provisionally highlighted here.
5. There are no flat-butted cordates present in the below datum and above datum samples, and no ficrons in the above datum sample. Cleavers, ficrons and flat-butted cordates are all present in the datum sample. However, it is argued that the sample sizes are too small (particularly given the low proportions of these artefacts in the overall assemblage) to place any emphasis on this patterning. This is also the case with tranchet tips, which only occur in the above datum sample.
6. Plano-convex bifaces show a wider range of types in the datum sample, although this is probably related to sample size. In all samples, cordate/ovate forms are well represented.
7. The sample sizes associated with asymmetrical (lop-sided) forms are too small to place emphasis on any apparent patterns in the data.

In conclusion therefore, the data suggest a general trend of stasis in the biface sub-assemblages distributed through the Broom sedimentary sequence, with little evidence of change through time. This trend may reflect either:

1. General stability in biface manufacturing techniques over a series of behavioural episodes involving the (probable) manufacture and discard of bifaces by hominids on the River Axe and River Blackwater floodplains and surrounding valley slopes. This interpretation argues that the sub-samples are not only stratigraphically distinct in the Broom sedimentary sequence, but are also chronologically-distinct — i.e. they represent a series of hominid visits to the river valley that are separated in time over the several millennia during which the Broom sediments accumulated (following the broad trends evident in the OSL geochronology and other sedimentological evidence from Broom (chapter 3)):

Hominid activity (biface discard) > entrainment into fluvial system > deposition > time interval (unspecified) > hominid activity (biface discard) > entrainment into fluvial system > deposition > time interval (unspecified) > …

2. General stability in biface manufacturing techniques over a single behavioural episode involving the (probable) manufacture and discard of bifaces by hominids on the River Axe and River Blackwater floodplain and surrounding valley slopes. This interpretation argues that although the sub-samples are stratigraphically distinct in the Broom sedimentary sequence, they are *not* chronologically distinct — i.e. they represent a 'single' hominid visit/occupation of the River Valley. The bifaces were gradually entrained into the fluvial system and deposited into the Broom sediments over several millennia (following the broad trends evident in the OSL geochronology and other sedimentological evidence (chapter 3)).

It should be apparent that these alternative interpretations provide a rather different view of hominid behaviour with respect to stone tool production. The first argues for general stability in stone tool production over multiple generations by hominid groups that may be unrelated (at least in terms of knowledge transmission). The second argues for short-term stability, but makes no assumptions about the potential for change and flexibility in stone tool technology over long time-spans. Evaluation of these alternative models is therefore important (and difficult) and is undertaken both in the next section (which explores the evidence for spatial patterning in these data) and in the next chapter (which applies models of fluvial systems to the issue of assemblage formation and chronological models). Finally, it is also stressed (and this point will be returned to in the conclusion to this chapter), that these models are discussing stone tools and possible technological 'uniformity', and not necessarily behavioural uniformity.

6. SPATIAL ORIGINS OF THE ASSEMBLAGES

Alongside the issue of change through time, a key question concerned whether there was evidence for changes in the biface assemblage in space — in other words, whether different types of artefacts were manufactured and/or discarded in different parts of the fluvial landscape. This is a critical question when investigating the archaeology and behaviour of early hominids, as it focuses upon the question of whether their behavioural repertoire incorporated a version of 'cultural geography' (Binford 1987) — the 'mapping' of specific tasks and activities to selected and varied locations in their landscapes. It should be emphasised that this approach assumes that behavioural variability can be detected through patterns in stone tool assemblages. As with the previous analysis, the division of the assemblage into spatial sub-units sought to test whether:

1. There were significant differences in the typological composition of the biface component in each of the sub-units.
2. There were significant differences in the technological aspects (e.g. raw material type and form) of the biface component in each of the sub-units.

The sub-division of the assemblage into two spatial sub-units was based upon the modelled biface transport distances (Section 3). The sub-300m sample included bifaces with modelled transport distances of less than 300m (89%, n=843); while the 300m+ sample includes bifaces with modelled transport distances of more than 300m (11%, n=108). This sub-division supported the distribution of the full assemblage (Figure 137), which suggested a concentration of material from a location(s) within *c*. 300m of the Broom sediments, with smaller numbers of bifaces scattered across the landscape, at greater distances from the Broom deposits. The sub-300m sample is described here as an on-site patch, while the 300m+ sample is described as an off-site scatter, following the terminology of Foley (1981). The analysis was therefore testing whether the bifaces from a small, spatially-delimited catchment source displayed significantly different attributes to material that was scattered over a wider source area.

This spatial sub-division makes no assumptions as to any chronological associations between the two sample units. The analysis is concerned with the presence (if any) of typological/technological trends associated with the deposition of bifaces in different locations and different contexts (repetitive deposition of artefacts in a 'single' location versus the sporadic deposition single artefacts in multiple, unique locations) in a fluvial landscape.

Comparison of the typological and technological characteristics of the two sub-units indicates little significant variation, either from each other, or the overall assemblage pattern (Section 3). The sub-300m sample showed clear similarities with the overall assemblage (as might be expected, given that it represents a large proportion of the assemblage):

- Biface typology is dominated by cordate/ovate forms (29%, n=242), with significant numbers of cordate (20%, n=166) and pointed (11%, n=90) forms. There are small numbers of cleavers, ficrons and flat-butted cordates. The cordate/ovate types (42%, n=91) also dominated the asymmetrical (lop-sided) sub-sample (n=217), with significant numbers of cordates (21%, n=46). There are relatively few pointed forms (5%, n=11). Cordate/ovate (30%, n=50) and cordate (20%, n=32) forms also dominated the plano-convex biface sub-sample (n=164).
- Blank forms (Figure 161) were predominantly unidentified (61%, n=511), although those that were positively identified indicated a mixture of cobbles (39%, n=130) and flakes (55%, n=184).
- Raw material types (Figure 162) were dominated by medium-grained chert (47%, n=400), with smaller quantities of fine (29%, n=242) and coarse-grained chert (19%, n=156) and flint (5%, n=42).
- Tip types are dominated by irregular rounded (44%, n=375), rounded (14%, n=120) and ogee points (10%, n=86), although the previous comments regarding potential damage and alteration of biface tips during fluvial transport should be recalled. There are six (<1%) examples of tranchet tips.
- Butt types (Figure 163) were dominated by trimmed flat (55%, n=467) and trimmed (19%, n=160) types.

- Biface weight (Figure 159) was clustered between 100g and 600g (69%, n=375), with a total weight range of 2390g.
- Biface edges (Figure 164) were dominated by straight and sinuous profiles (96%, n=808), with the sample sub-dividing as follows: double straight edges (47%, n=396); straight/sinuous edges (27%, n=229); and double sinuous edges (22%, n=183). This overall pattern is replicated on asymmetrical (lop-sided) bifaces (n=217): double straight edges (52%, n=113); straight/sinuous edges (28%, n=60); and double sinuous edges (17%, n=36).

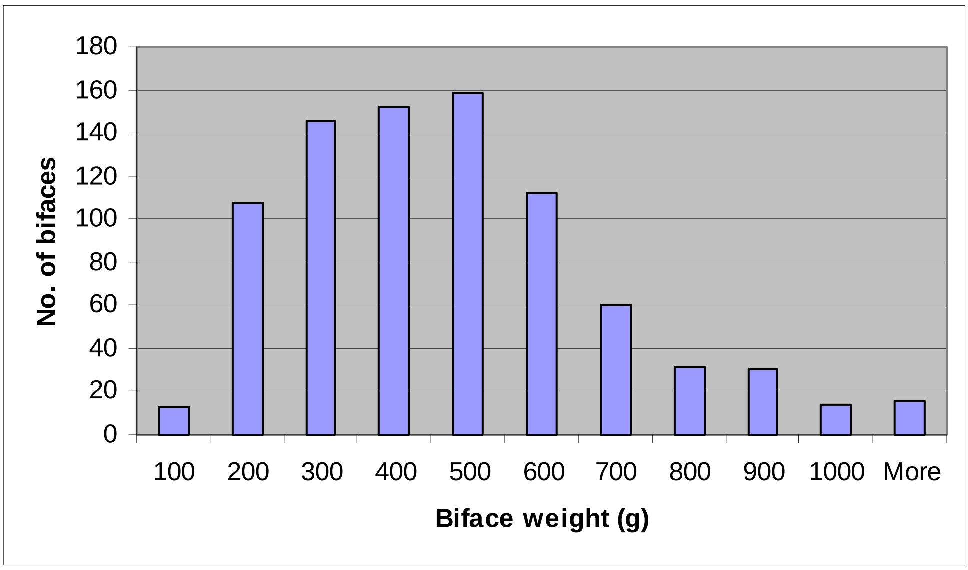

Figure 159: biface weight distribution (sub-300m sample)

The 300m+ sample also shows numerous similarities with both the overall assemblage and the sub-300m sample:

- The primary biface type is the cordate/ovate form (23%, n=25), but it is not as dominant as in either the sub-300m sample or the overall assemblage. There are also small numbers of all the major categories: cordate forms (15%, n=16); pointed forms (13%, n=14); sub-cordate/cordate (10%, n=11); sub-cordate/ovate (9%, n=10); ovate forms (8%, n=9); pointed/sub-cordate (6%, n=7); and sub-cordate (5%, n=5). There are also very small numbers of cleavers, ficrons and flat-butted cordates. Cordate/ovate, cordate and sub-cordate/ovate bifaces make up the very small asymmetrical (lop-sided) sub-sample (n=10). Cordate/ovate (40%, n=6) forms dominate the small plano-convex biface sub-sample (n=15), with very small numbers of the other main types.
- Blank forms (Figure 161) were predominantly unidentified (70%, n=76), although those that were positively identified indicated a mixture of cobbles (47%, n=15) and flakes (53%, n=17).
- Raw material types (Figure 162) were dominated by medium-grained chert (47%, n=51), with smaller quantities of fine (21%, n=23) and coarse-grained chert (19%, n=21) and flint (12%, n=13).
- Tip types are dominated by irregular rounded (49%, n=53), rounded (18%, n=19) and ogee points (10%, n=11), although the previous comments regarding potential damage and alteration of biface tips during fluvial transport should be recalled. There are three (3%) examples of tranchet tips.
- Butt types (Figure 163) were dominated by trimmed flat (51%, n=55) and trimmed (32%, n=30) types.
- Biface weight (Figure 160) was clustered between 100g and 400g (61%, n=66). The total weight range is 927g.
- Biface edges (Figure 164) were dominated by straight and sinuous profiles (95%, n=515), with the sample sub-dividing as follows: double straight edges (49%, n=53); straight/sinuous edges (22%, n=24); and double sinuous edges (20%, n=22). This overall pattern is generally replicated on

asymmetrical (lop-sided) bifaces, although the sample size is too small (n=10) to discuss this in greater detail.

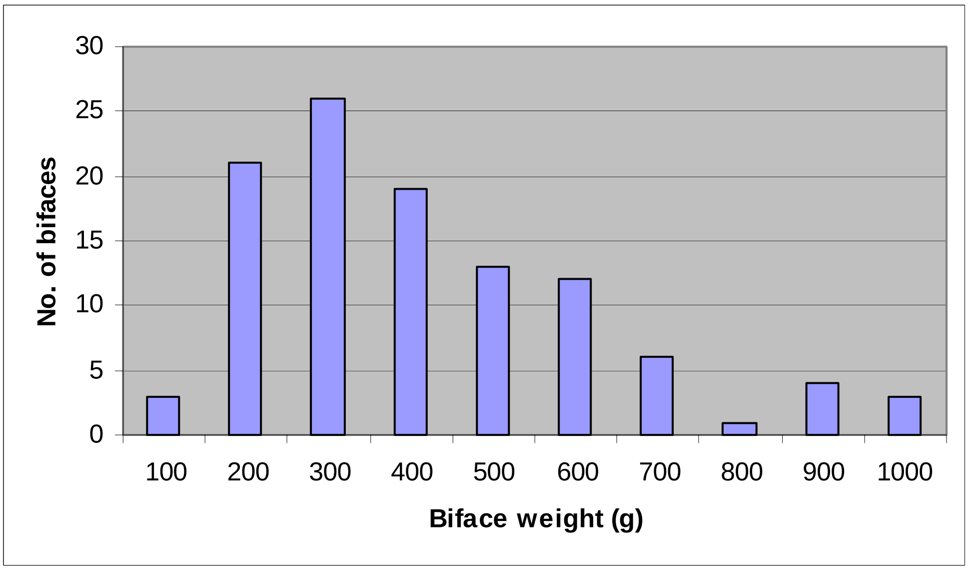

Figure 160: biface weight distribution (300m+ sample)

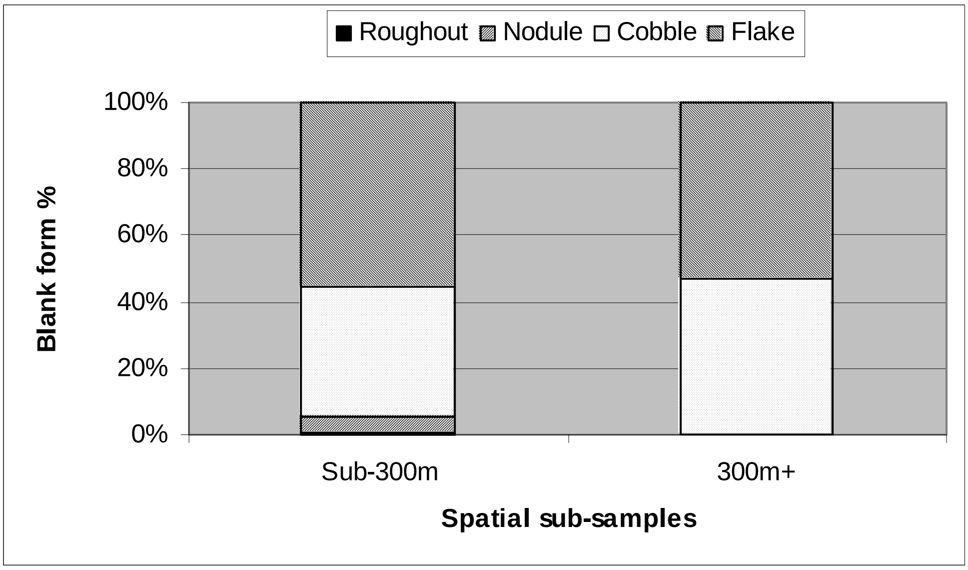

Figure 161: blank form distribution, by spatial sub-sample

The patterns evident in the two sub-samples suggest that there are no significant variations in the typological and technological composition of the biface assemblages distributed across the Axe valley landscape. Specifically, the following points are stressed:

1. There are no major changes in the pattern of bifaces types in the two samples, although the cordate/ovate form is more dominant in the sub-300m sample than in the 300m+ sample. Nonetheless, the same range of types is represented in both samples.
2. There are no major variations in the patterns in raw material usage (primarily medium-grained chert), blank forms preference (both cobbles and flakes are common), tip types (irregular rounded — but recall comments regarding fluvial damage to biface tips), butt types (trimmed flat and trimmed types) and edge types (double straight, straight/sinuous, and double sinuous profiles) in either sample.

3. The low level usage of flint in both samples suggests that this raw material was not abundantly available from any location within the Axe Valley environment around Broom (this again assumes that flint would have been a preferred material when it was 'easily' obtainable). However (as also noted in the previous section), it is worth emphasising that flint may not have been a highly sought after raw material, given that fine-grained chert materials were readily available and possessed a similar range of flaking properties.
4. Smaller artefacts (as measured by weight) were more common in the 300m+ sample. This pattern may suggest the quality and/or size of available raw materials in certain locations of the Axe Valley landscape, or a tendency for the discard (and use?) of smaller bifaces away from the major catchment zone (or to look at it the other way on, the discard of heavier bifaces in the major catchment zone). The data possibly suggests differential behaviour over the landscape, although there is not extensive support for this hypothesis from other data patterns in the assemblage.
5. Cleavers, ficrons and flat-butted cordates occur in both samples, suggesting no clear link between these distinctive types and different locations in the landscape. Tranchet tips also occur in both samples.

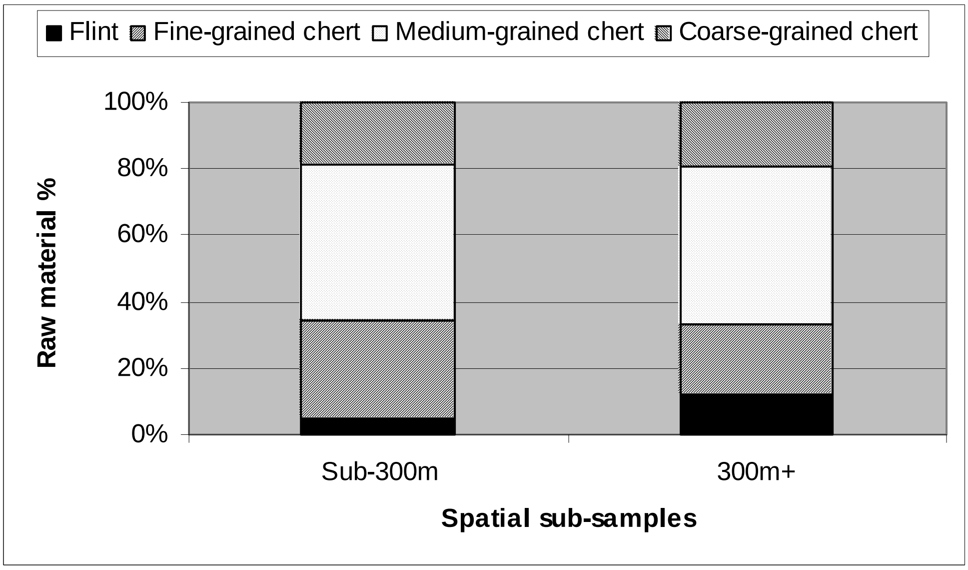

Figure 162: raw material distribution, by spatial sub-sample

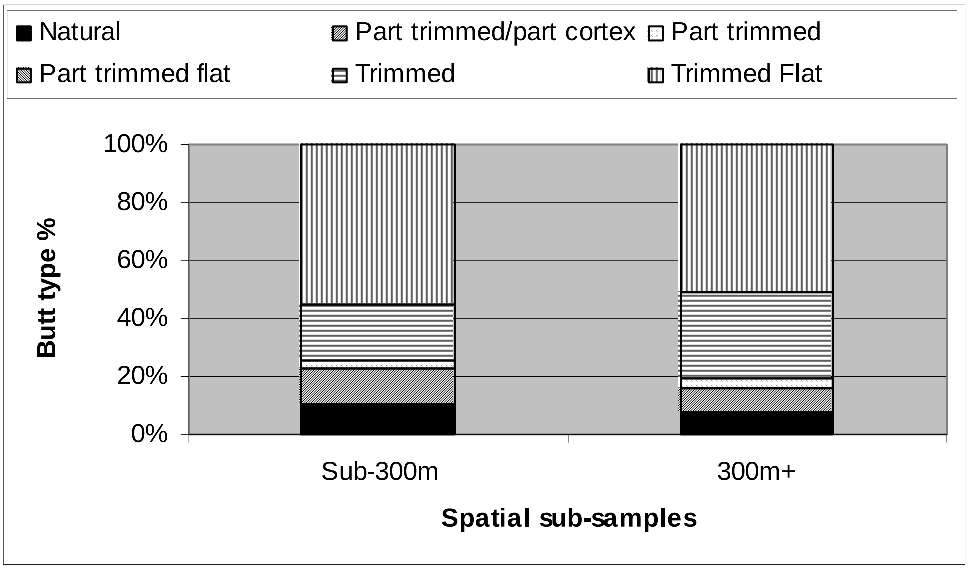

Figure 163: butt type distribution, by spatial sub-sample

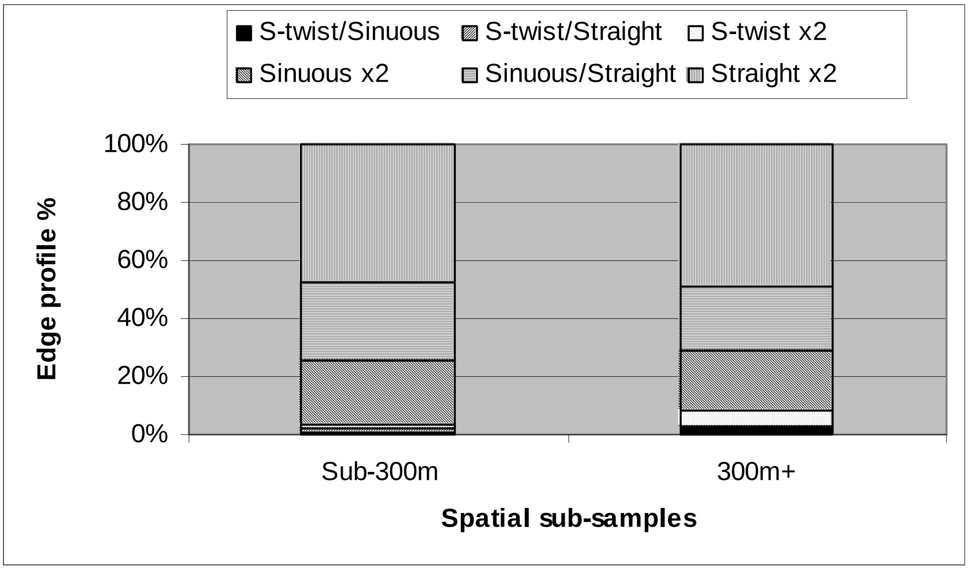

Figure 164: edge profile distribution, by spatial sub-sample

6. Plano-convex and asymmetrical (lop-sided) bifaces demonstrate a similar range of types in both samples, and in all cases, cordate/ovate forms are the prominent biface type.

In conclusion therefore, the data suggest a generally homogenous pattern with respect to the inter-sample technological and typological characteristics of the bifaces discarded in a 'single' on-site location close to the Broom sediments, and those bifaces discarded off-site across a wider area of the Axe Valley landscape. Two potential interpretations are suggested:

1. There is no stone tool evidence supporting a Binfordian model of cultural geography (Binford 1987), as there is no suggestion that different activities (requiring specific biface types) were undertaken in specific areas of the landscape. In particular, the pattern of biface types might be expected to differ markedly between the large, spatially-localised sample (on-site patch) and the smaller, spatially-dispersed sample (off-site scatter). It should be stressed however, that if behavioural variability and flexibility is not reflected in stone tool technology, then it is not possible to assess claims for a cultural geography using this type of approach.
2. However, if either or both of the two samples represent a palimpsest of material that accumulated over decades or centuries, then it can be argued that original spatial patterning in the data (which might be supportive of a cultural geography) is blurred due to over-printing (e.g. activity x is undertaken at location y, followed subsequently by activity y at location y, resulting in a 'mixed' assemblage at location y). However, we would argue that this interpretation is partially disputed by the evidence from the stratigraphical samples, which suggest that there is not distinctive inter-sample variation through time, only further examples of intra-sample variability (see also Section 7).

These patterns and data-sets also raise a number of additional issues:

1. The reason behind the apparent existence of a small source area for *at least c.* 840 of the Broom bifaces remains unclear. It is possible therefore that the location was favourable due to unknown factors such as a river crossing point for animals and/or hominids, or a favourable foraging/gathering/hunting location, which resulted in hominids being repeatedly attracted to the location and discarding the stone tools associated with a range of subsistence activities. Under such a model, the bifaces from the wider landscape represent the residue from the occasional activities that were undertaken in these less attractive areas of the landscape (e.g. the product of chance resource encounters).

2. The assemblages reveal extensive intra-sample variability (in biface form, tip and butt types, raw material usage, blank form preference, and edge profiles), at least according to modern archaeological classification methods. Yet, there is little or no inter-sample variation. The absence of inter-sample variability in space suggests that the intra-sample variation is not due to functional requirements (i.e. type x is made to do task y) nor that there were clear links between specific types and set tasks (if this was the case, one would expect to see greater differences in the composition of the high density (on-site patch) and low density (off-site scatter) samples. Rather, it suggests that there is a general absence of enforced standardisation onto the process of biface manufacture, which is also suggested by the extensive intra-sample variation in raw material usage, blank form types and other elements of manufacture.

The data therefore suggests that there is little evidence for a cultural geography being practised in and around the Axe Valley environment (or at least not one that is represented by the stone tool record). Nonetheless, there does appear to be evidence for an 'on-site'/'off-site' patterning in the spatial distribution of the discarded artefacts, with probable evidence for repetitive visits to a specific locale. This represents currently unknown factors (we suggest the location of key environmental resources as a strong possibility), but of greatest interest is the apparent lack of standardisation in the stone tools discarded, both at this locale and across the wider landscape.

Having demonstrated a spatial patterning in the distribution of bifaces in the Axe Valley, a key question concerns whether that type of patterning is typical of fluvial secondary context assemblages. Examination of other secondary context assemblages allows an assessment of or whether different assemblages reveal different patterns, reflecting wider variations in landscape behaviours. A comparison was therefore undertaken with the Lower Palaeolithic site of Dunbridge (Section 6.1), with particular focus on the issues of assemblage formation and the spatial signatures of the biface component of the assemblage.

6.1 Dunbridge Lower Palaeolithic assemblage

The Dunbridge gravel pits lie to the west of the river Test, immediately below its confluence with the tributary river Dun. The gravel deposit rises away from the river, reaching over 40m OD. The gravel pits have predominantly exploited the lower deposits adjacent to the river, cutting into the northern edge of the gravel and facing the river Dun. The workings have exposed the largest collection of Palaeolithic artefacts from a single locality in Hampshire, and there are further low-level pits on the eastern edge of the gravel deposit at Kimbridge (Bridgland & Harding 1987: 50).

The gravels at Dunbridge were extensively worked during the first quarter of the 20th century. Collections were made by William Dale (1912a, 1918), a local Southampton-based antiquarian, and there are also references to the site by Sturge (1912) and R.A. Smith (1926). Roe (1968a: 96) listed 1021 artefacts, including 953 bifaces (93.3%). The ratio of bifaces to non-biface artefacts in the extant assemblage is thus similar to that from Broom. The remainder of the Dunbridge assemblage includes 14 roughouts, 3 cores, 16 retouched flakes, 24 unretouched flakes, 8 miscellaneous pieces, and 3 Levallois flakes. A watching brief was undertaken during the 1990's at the Kimbridge Farm pit (adjacent to the old Dunbridge site), by Phil Harding of Wessex Archaeology. This work produced a far lower ratio of bifaces to other collected artefacts. The composition of Roe's assemblage undoubtedly reflects selective collection during the early part of the 20th century, although it is difficult to know whether this due to the labourers, the antiquarians or both.

Dale (1912a) described up to 7m of gravel at Dunbridge, overlying an irregular surface cut into clays and sands of the Woolwich and Reading Beds (Figure 165). Dale also suggested that palaeoliths with different states of preservation had originated from different stratigraphic levels in the gravel. It was proposed that the sharp, white implements from the upper deposit were of a 'later character' than those from the lower beds (Dale 1918). The sub-division of the gravel deposit was based on colour: a lower, dark red gravel, a middle yellow-brown gravel and an upper white gravel. Dale subsequently modified this interpretation and suggested that the gravel of two periods was present. In this later view, an upper, paler deposit was separated from a lower, darker aggradation by an iron pan horizon. Bridgland & Harding (1987: 50) suggest that the middle and lower units of Dale's earlier, tripartite division had been combined into the lower, darker aggradation of the later interpretation. Dale's (1912a, 1918) observations suggested the possibility that different Lower Palaeolithic industries existed in stratigraphic superposition at Dunbridge. Following these claims Roe (1981) examined the range of material from the site and was able to identify the white material described by Dale.

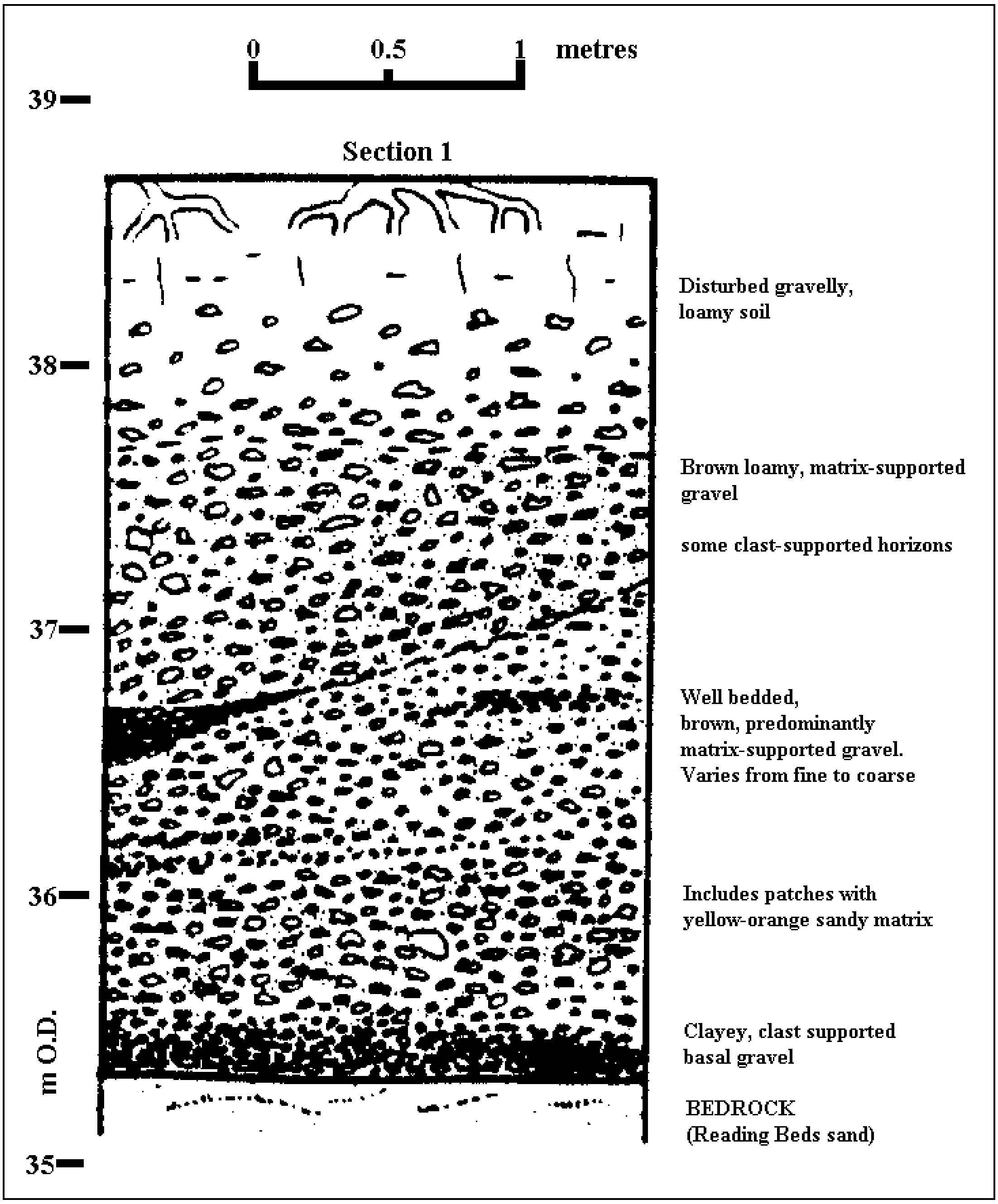

Figure 165: section from the Lower Palaeolithic site at Dunbridge (after Bridgland & Harding 1987: figure 5)

Dale (1912b) recognised separate 100 and 150 foot gravels at Dunbridge and Kimbridge. Although geological mapping indicated a single spread of gravel, the geological memoir (White 1912) recognised two levels. White (*ibid.*) described an upper Belbins stage (21m above river level) and a lower Mottisfont stage (12m above the river), both yielding Palaeolithic materials. White assigned the Dunbridge gravel to the Belbins stage and the Kimbridge gravel to the Mottisfont stage. He also disputed Dale's (1912a, 1912b) claims that the Dunbridge deposits might have a sub-glacial origin.

Bridgland & Harding (1987: 51) excavated three sections at the old Dunbridge workings in 1986. They noted that the deposits were of a brown, ferruginously stained appearance and were unable to subdivide the gravel into upper white and lower darker units. The single iron pan horizon could also not be identified. White patinated flints were recorded in the upper layers of sections 2 and 3, but they were also observed from lower down in section 3.

In 1991, four sections were recorded at the Kimbridge Farm site (Bridgland & Harding 1993). A distinction was drawn here between lower, well-bedded, generally unbleached gravel, and an upper, poorly bedded or unbedded, generally bleached gravel. The bleached and unbleached gravels were typically separated by a persistent iron / manganese pan, although the pan did not necessarily coincide with the top of the well-bedded gravel. This distinction, not apparent in the 1986 sections, may support Dale's (1912a, 1918) stratigraphic claims (Bridgland & Harding 1993: 8–9).

The Dunbridge assemblage therefore appears to provide highly comparable lines of enquiry to Broom, with respect to the claims for stratigraphically-distinct assemblages (deposited at different heights in the sedimentary sequence) and 'upper' and 'lower' sedimentary gravel units. However, the difficulties encountered by Bridgland & Harding (1987, 1993) in the division of the sediments and the general absence of documentary evidence pertaining to artefact collection and provenance, mitigates against a stratigraphically-driven analysis of the assemblage. Focus was therefore placed on abrasion modelling of the biface component of the assemblage, with a view towards reconstructing the artefacts' spatial catchment and models of landscape archaeology.

6.1.1 Dunbridge Biface Abrasion

A sample of 166 bifaces from the Dunbridge assemblage were analysed and compared to the experimental abrasion development data set. The biface sample comprises of those artefacts held by Winchester (Hyde Street) Museum, Southampton (God's House Tower) Museum and the Hampshire County Museum Stores (Chilcombe House, Winchester). All artefacts were manufactured in flint. During the course of this analysis it was not possible to identify any of the 'sharp, white patinated' artefacts described by Dale (1912a). The sampled artefacts all displayed some degree of iron-staining and signs of fluvial transportation damage.

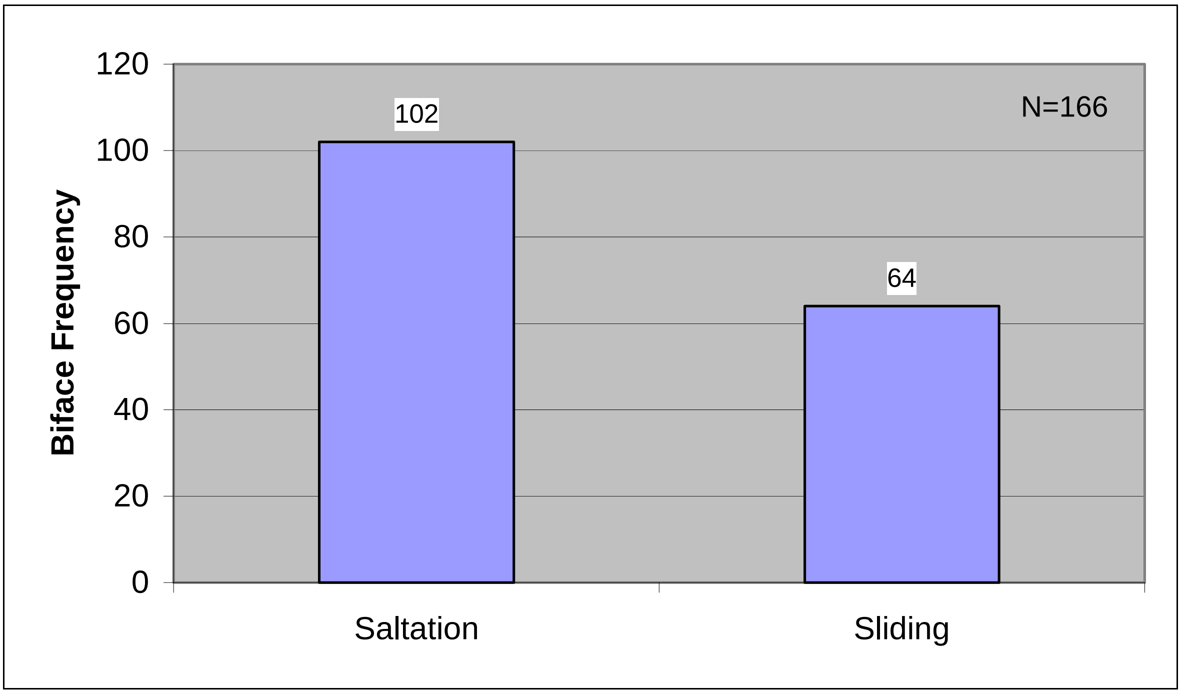

Figure 166: occurrences of saltation and sliding movement within the Dunbridge biface sample

Of the 166 Dunbridge bifaces examined, 102 showed arête and edge damage patterns indicative of saltation transportation regimes, while the remaining 64 artefacts displayed sliding damage patterns (Figure 166). The two transportation regime populations are discussed separately below.

1. The Dunbridge saltation sample: Figure 167 shows a breakdown of the Dunbridge saltation sample at intervals of 100m. It can be seen that, as in the Broom population, there is a notable peak in artefact frequency distribution that can be seen around the 200–300m range.

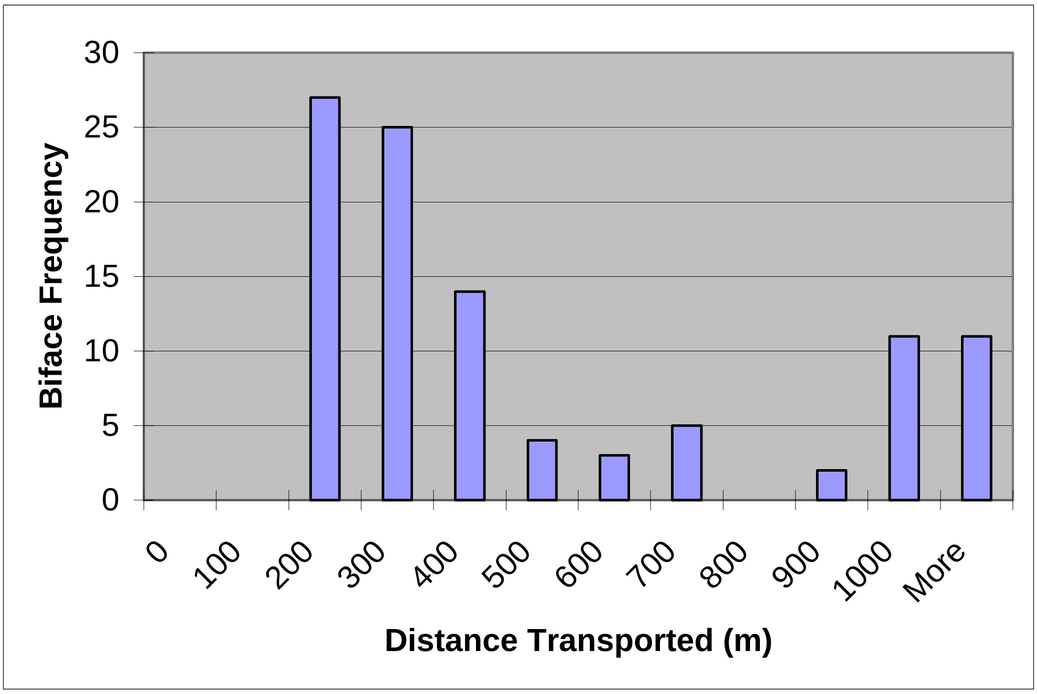

Figure 167: Dunbridge biface sample, transported by saltation

The Dunbridge saltation population does not contain any artefacts from the immediate vicinity, all examined bifaces appeared to have been transported for distances of 200m or more and a greater proportion of the population has been transported significantly further.

2. The Dunbridge sliding sample: Figure 168 shows a breakdown of the bifaces in the Dunbridge sample that showed evidence of fluvial transportation via sliding motion. Unfortunately experimental modelling of sliding damage development could only be documented up to a distance of 250m. The Dunbridge sliding sample has predominantly sustained more damage than the flint experimental sliding data set. It can be postulated therefore that these Dunbridge bifaces have slid for distances greater than 250m. Constraints in the experimental data set prohibit the modelling of the specific distances that this additional damage pertains to. As with the saltation sub-sample, there is no evidence that any of the bifaces transported by sliding originated from the immediate vicinity of the Dunbridge pits.

In general however, the Dunbridge biface sample shows a higher proportion of highly transported material than the Broom assemblage. The two assemblages are therefore compared in more detail below (Figure 169–Figure 170), with respect to the transportation characteristics of the bifaces, the fluvial catchments for the two sites, and their implications for models of hominid landscape behaviour.

Due to the substantial differences in assemblage size, the two data sets are compared on a percentage basis, facilitating a more representative evaluation of the transportation trends present than a raw data count would allow. A comparison of the components of each assemblage that show evidence of transportation via primarily saltation motion, reveals that both the Broom and Dunbridge samples are characterised by concentrations of bifaces which have travelled approximately 200–300m from their original point of discard (Figure 169). However, the dominance of this distance category is much more pronounced within the Broom population (84% (n=498) compared to 51% (n=52) in the Dunbridge sample). In contrast, the Dunbridge population is characterised by a greater % of more heavily abraded bifaces (49% (n=50) compared to 16% (n=94) from Broom), whose abrasion damage signatures are indicative of longer transportation distances.

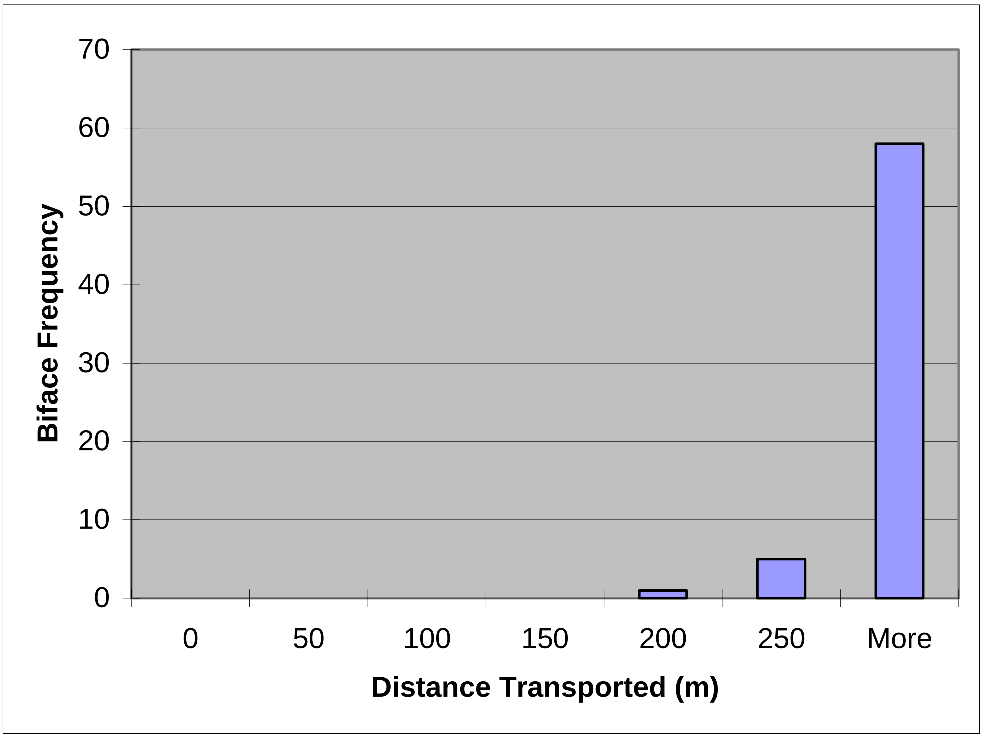

Figure 168: Dunbridge biface sample, transported by sliding

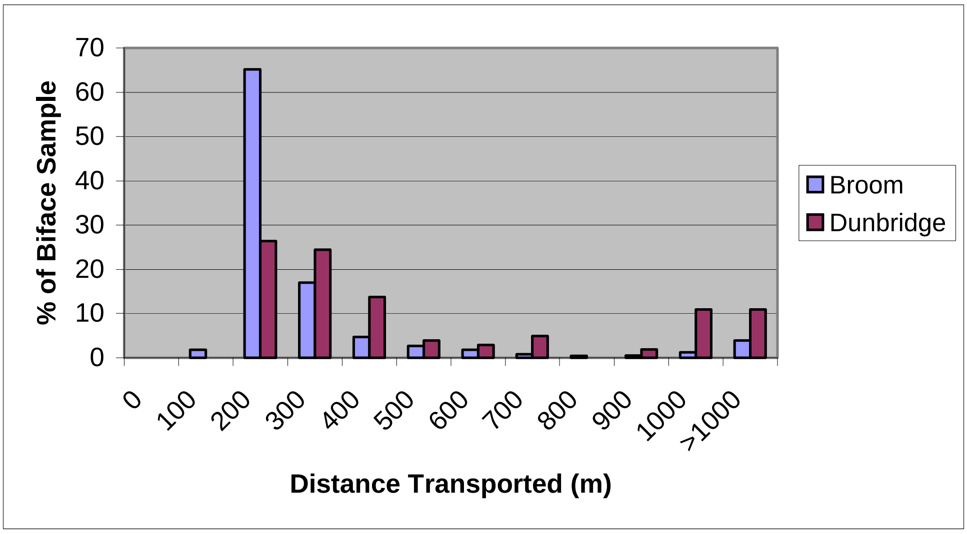

Figure 169: comparison of Broom and Dunbridge bifaces transported through saltation

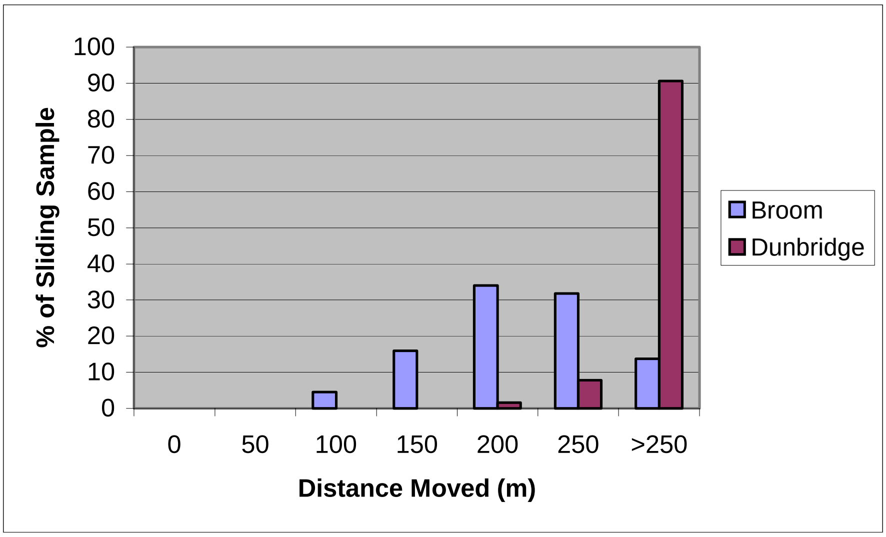

Figure 170: comparison of Broom and Dunbridge bifaces transported through sliding

The comparison of the bifaces transported primarily by sliding, also suggested that the Broom sample was characterised by a higher proportion of locally-derived (defined here as sub-200m) bifaces (55%, n=24). In contrast, the Dunbridge material had a very small component of locally-derived material (2%, n=1), with the vast majority of the bifaces characterised by damage signatures indicative of transportation greater than 250m (Figure 170).

In conclusion, the data from Broom suggested a predominance of locally-derived material in the assemblage. Very small quantities of the sampled bifaces suggested transportation distances greater than 500m. With respect to hominid activity in the Axe Valley, these data suggest repeated visits (rather than a 'single' occupation) to a spatially discrete locality, in the vicinity of the Broom pits. Although the attractions of this locality cannot be proven, the probabilities include mobile resources (animal species), static resources (water, lithic raw materials), and landscape logistics (e.g. river crossings and ease of movement). The data also indicate sporadic activity distributed more widely across the landscape. The inter-sample homogeneity of the assemblages suggests that similar behaviours were conducted throughout the Axe Valley landscape. Finally, the intra-sample technological variation suggests that the spatially discrete locality was not a task-specific site, and there is no evidence for the existence of cultural geography as defined by Binford (1987).

The Dunbridge data indicates partial similarities with Broom (approximately half of the sampled bifaces are locally derived from with 200–300m of the modern pits), but there is also evidence of a wider artefact catchment area. These data would suggest a combination of wide-ranging behaviour over the River Test landscape and intensive activity at a spatially discrete locality in the vicinity of Dunbridge, although the absence of clear stratigraphic provenancing for the artefacts make it difficult to say whether this reflects a series of visits or a single phase of occupation. Given the location of the Dunbridge sediments at the geological interface between Upper Cretaceous chalk to the north and Tertiary sands and clays, the latter pattern may reflect the acquisition of high quality raw material (flint nodules as opposed to river cobbles — White 1998b) from chalk outcrops. The concentrated deposition at Dunbridge of bifaces from across this wide catchment area is probably due to geological and fluvial geomorphological factors. Specifically, the restrictive impact of chalk bedrock on river terrace development (chalk river valleys are narrow and lack long terrace staircase sequences) and fluvial migration (Bridgland 1985; Hosfield 2001). These factors may have resulted in the extensive spatial re-working of the artefacts in the chalk river Test valley, prior to their deposition at Dunbridge in fan gravels/preserved terrace deposits. The deposition of the fan gravels and preservation of terrace deposits are associated with the interface of bedrock chalk and bedrock sands and clays, and the resulting changes in fluvial system behaviour (this point is discussed at greater length in the following chapter).

This comparison of derived data sets has therefore indicated general similarities, with both sites indicating concentrated hominid activity in the local vicinity. They also both demonstrate that hominid activity was not limited to 'sites' and reveal their exploitation of the wider fluvial landscape. It should be stressed that the landscape has often been ignored in traditional interpretations of these assemblages. Most importantly, this work has demonstrated the potential for inter-site comparisons and the investigation of off-site patterns in hominid behaviour across fragmented Palaeolithic fluvial landscapes.

7. ASSEMBLAGE CHARACTERISATION & CONCLUSIONS

The Broom assemblage can be characterised in terms of its technological and typological characteristics, alongside the evidence for patterning through time and in space:

1. The following discussion of technological and typological patterning in the Broom assemblage stresses intra- and inter-sample trends. Intra-sample patterning refers to trends within an individual sample, which could be the overall assemblage sample (n=977) or the below-datum sample (n=52). Inter-sample patterning refers to comparisons between individual samples. The following discussion is predominantly concerned with the biface element of the assemblage, given the high proportion of these artefacts and their greater potential for informative patterning.

   The assemblage shows considerable intra-sample variation in all of the major categories (biface type, raw materials, blank form, tip and butt types, edge profiles, and size (weight)). Although in many of these categories, there was a dominant type (e.g. cordate/ovate bifaces, medium-grained chert, irregular rounded tips, trimmed flat butts, and bifaces between 100–500g), the range of other types indicate considerable variation in technological practise and the end products of knapping activity. These patterns do not suggest strongly imposed standardisation with respect to the production of artefacts. This is also supported by the absence of inter-sample variation (discussed further below), evident in the stratigraphic sub-samples and the spatial sub-samples.

   There is a strong preference for the production of straight edges, suggesting that the knappers' were concerned with the production of good cutting edges on the bifaces. This is further supported by the dominance of trimmed or trimmed flat butts, suggesting the production of bifaces with fully circumferential cutting edges. The dominance of straight edges for all the major biface types at Broom further suggests that efficient cutting edges were required, regardless of the overall biface form (it is possible that the different combinations of cutting edges and biface forms might have afforded a wide range of task-related ergonomic tools).

   In contrast to the claims made by C.E. Bean, asymmetrical (lop-sided) biface forms do not dominant the assemblage (Bean claimed that this type 4 represented *c.* 50% of his collection). No evidence has been found to support Bean's claim that the asymmetrical bifaces were produced on side-struck flakes (and 12 of the asymmetrical bifaces were shown to have been produced on cobbles). Nonetheless, these forms are relatively common (19.5%, n=125), occurring on all raw material types. This implies that the asymmetry was not a consequence of raw material type. A wide range of biface types are represented on these asymmetrical forms, suggesting either that the asymmetry was an unintentional product of the knapping process (and that biface form was significant); or vice-versa (that the asymmetry was an intended end goal, and was considered to be more important than biface form). It is currently not possible to evaluate one interpretation over the other, although the dominance of straight edges on these forms suggests that they may have been no less functional than the 'symmetrical' bifaces.

   The non-biface assemblage is dominated by retouched flake tools. Given the collection history at the site, it seems likely that this dominance of the retouched flake tools and unifaces over non-retouched débitage is a factor of their high degree of working and therefore unambiguous artefact status. The continued recovery of flakes in the 1980's (by C.P. Green) and the 2000's (by Hosfield & Chambers) also suggests that the débitage component in the Bean collection is highly under-represented. It is therefore not possible to reconstruct knapping behaviour in the Axe Valley.

However, the presence of non-biface stone tools indicates that activities beyond those traditionally associated with biface use (e.g. butchering large animals) were being conducted within the demonstrated fluvial catchment area.

2. Division of the Broom biface assemblage into stratigraphic sub-samples was based primarily on the Bean archive and the previous work of Green (1988). Although it yielded relatively small samples (due to the number of accurately provenanced bifaces in the Bean archive), the samples suggested generally robust patterning. All three sub-samples were characterised by intra-sample variation that was similar to that of the overall assemblage sample (see point 1 above). However, there was very little inter-sample variation, suggesting little change through time in hominid behaviour (as represented by stone tools). In this respect, Broom is notably different to Swanscombe, where fundamentally different stone tool industries (Acheulean and Clactonian) lie in stratigraphic superposition within a single MIS-cycle (Conway *et al.* 1996; Wymer 1999). The OSL dates for the Broom sediments (see module 2) suggest that this time-span *could* represent as much as 20,000 years, raising the possible issue of each sub-sample representing a palimpsest. However, the compositional similarity of the three stratigraphic samples suggests that the intra-sample variability is not due to time-averaged over-printing, since it would require the same sequence of over-printing to occur three times, a scenario for which there is no analogue.

   It is acknowledged that the similarity of the above datum sample (broadly associated with the upper gravels) and the datum sample (associated with the middle beds) may be due to the artefacts ultimately recovered from the upper unit having been eroded out of the finer-grained and less resistant sediments of the middle beds, prior to and during the deposition of the upper gravels (Green pers. comm.). However, such a process does not explain the similarities between the artefacts of the middle beds and the lower gravels, and it is also not supported by the physical condition of the above datum sample artefacts, which did not display evidence of more intensive transportation and re-working when compared to the datum sample.

   Indeed, the modelled abrasion data for the three sub-samples shows a very similar pattern (the majority of the material appears to be derived from a local source catchment), suggesting that the spatial foci of hominid behaviour in the River Axe landscape (as represented by biface discard) remained consistent through time. The physical condition of the majority of the bifaces (e.g. edge damage) suggested that they were primarily transported and deposited in the coarse-grained gravels which occur throughout the Broom sedimentary sequence (including the Middle Beds), rather than being discarded *in situ* in the fine-grained sediments, as suggested by C.E. Bean.
   As c. 85% of the assemblage could not be stratigraphically provenanced, it is possible that there is greater inter-sample variation at Broom which cannot be demonstrated. However, on the basis of the current analysis, there is very little evidence for inter-sample variation. It is also possible that the lack of inter-sample variation is due to the three samples being stratigraphically separated in the Broom sediments, but originating from a 'single', homogeneous occupation. We would argue however, that this hypothesis requires a complex model of episodic artefact supply into the fluvial system (either as a result of fluvial erosion of floodplain sediments or sediment movement from valley slopes). Further discussion of these issues is introduced in the next chapter.

3. Division of the Broom biface assemblage into spatial sub-samples was based on the artefact abrasion modelling work of Chambers (in prep). The samples suggested robust patterning, with a large concentration of bifaces derived from within a few hundred metres of the Broom pits. The remainder of the bifaces were derived from a wider source area, although there was very little material that could be demonstrated to have been transported from further than *c.* 1km upstream. These samples are described as on-site and off-site material respectively, although the terms are not strictly used in the Foley (1981) tradition. Both samples are characterised by intra-sample variation that is similar to that of the overall assemblage (see point 1 above). There was also (as with the stratigraphic samples) very little inter-sample variation, suggesting little spatial variation in hominid behaviour (as represented by stone tools). This would suggest an absence of a cultural geography (e.g. the existence of task-specific sites, the creation of taskscapes or the spatial

differentiation of landscapes) (Binford 1980, 1987; Ingold 1993; Gamble 1999). In contrast, in so far as can be demonstrated by biface manufacturing techniques and discard patterns, there appears to be a high degree of behavioural homogeneity across the modelled landscape.

The apparent intra-sample variability in the on-site sample could be argued to result from over-printing and the generation of a palimpsest assemblage over an extensive time-span. However, we would argue that the patterning in the stratigraphic samples (of intra-sample variability and inter-sample similarity over time) *suggests* that this is not the case and that the intra-sample represents relatively short-term trends in technological practice. It is of course difficult to independently assess whether the on-site sample (and the off-site sample) represents a 'single' occupation or repeated visits to the landscape over a long period of time. However, the stratigraphic range of the artefacts in the Broom sediments suggests that the latter rather than the former is the case, supporting an over-arching model of behavioural homogeneity in time as well as space.

In conclusion, this analysis of the secondary context archaeological assemblage from the Broom Lower Palaeolithic locality archaeology has highlighted a series of important archaeological applications:

1. That it is possible to extract meaningful archaeological information from derived, secondary context data sets, with respect to behavioural homogeneity/heterogeneity in space and time.
2. That assessments of the spatial and temporal origins of Palaeolithic artefacts in derived contexts can be made.
3. That it is possible to compare landscape archaeologies associated with separate secondary context Palaeolithic assemblages.

The following chapter continues to develop all of these themes, exploring wider issues of fluvial system behaviour, assemblage formation and their implications for the interpretation of archaeological data.