**[For ONLINE SUPPLEMENTARY MATERIAL]**

**Big enough to matter: on the frequency and chronology of giant handaxes in the British Lower Palaeolithic**

Luke Dale1,\*, Aaron Rawlinson1,2, Pete Knowles1, Frederick Foulds1 [ORCID: 0000-0003-3071-7187], Nick Ashton2 [ORCID: 0000-0001-9787-3892], David Bridgland3 [ORCID: 0000-0002-0843-3295] & Mark White1 [ORCID: Orcid ID: 0000-0002-2963-3106]

1 Department of Archaeology, Durham University, UK

2 Department of Britain, Europe and Prehistory, British Museum, Franks House, Orsman Road, London N1 5QJ, UK

3 Department of Geography, Durham University, UK

\* Author for correspondence ✉ bftbg@hotmail.co.uk

*Received: 1 October 2022; Revised: 16 March 2023; Accepted: 25 May 2023*

**1. Sites and assemblage selection**

Assemblages from 47 Acheulean sites were selected for study primarily on the basis of secure context within fluvial terrace deposits (Figure S1), from which correlations with the marine isotope curve have been made via a combination of lithostratigraphy, vertebrate and invertebrate biostratigraphy, optically stimulated luminescence and amino acid racemisation dating, but *not* the lithic record. Undated or uncertainly dated sites were selected only where they contained a large regional sample of handaxes not represented elsewhere. A list of the assemblages analysed, including data sources and references for their age attribution is provided in Table S1.

**Table S1. Sites selected for analysis, including length and size category data. S = small; A = average; L = large; G = giant. Where assemblage size equals 1, this indicates a specific giant handaxe selected for inclusion in the analysis. \*Data for Brandon Fields kindly provided by Paula García-Medrano and recorded as part of the Western European Acheulean Project. \*\*The absence of large and giant handaxes at Stoke Newington is a result of biases in collection and curation (see White 2023)—several examples of giants from this site have been identified but were unavailable for inclusion in the dataset at the time of writing. \*\*\*Lacaille’s (1960) record of a giant handaxe from Swanscombe notes it as being attributed to the Middle Gravels but provides no further information as to its location within this deposit—it is thus included alongside those handaxes from the Upper Middle Gravels recorded by White (1996).**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Length data** | | | | **Size categories** | | | |  |  |  |
| **Site** | **Mean  length (mm)** | **SD** | **Min. length** | **Max. length** | **S** | **A** | **L** | **G** | **Date** | **Data sources** | **Dating references** |
| Acton (*n* = 6) | 115.50 | 14.48 | 96 | 141 | - | 6 | - | - | MIS 10-9-8 | Dale 2022 | Ashton *et al*. 2003 |
| Baker's Farm (*n* = 30) | 133.97 | 34.87 | 67 | 209 | 2 | 19 | 9 | - | MIS 9 | Dale 2022 | Bridgland 1994 |
| Barnham Heath (*n* = 83) | 127.77 | 30.26 | 70 | 211 | 5 | 58 | 20 | - | MIS 10-9-8 | Dale 2022 | Davis *et al.* 2021 |
| Biddenham (*n* = 109) | 116.01 | 31.07 | 65 | 253 | 4 | 91 | 13 | 1 | MIS 10-9-1 | Dale 2022 | Westaway *et al*. 2006 |
| Bowman's Lodge (*n* = 29) | 88.38 | 25.93 | 47 | 140 | 13 | 16 | - | - | MIS 11 | White 1996 | Bridgland 1994 |
| Boxgrove (*n* = 82) | 120.94 | 25.39 | 67 | 191 | 4 | 70 | 8 | - | MIS 13 | White 1996 | Roberts & Parfitt 1999 |
| Brandon Fields (*n* = 50) | 110.64 | 23.01 | 70 | 170 | 4 | 42 | 4 | - | MIS 15 | WEAP\* | Davis *et al*. 2021 |
| Broom (*n* = 237) | 124.76 | 35.08 | 55 | 282 | 14 | 173 | 47 | 3 | MIS 9-8 | Marshall *et al*. 2002 | Hosfield & Green 2013 |
| Canterbury West (*n* = 18) | 158.67 | 48.44 | 81 | 285 | - | 10 | 6 | 2 | MIS 10-9-8 | Dale 2022 | Knowles in press |
| Cookham (*n* = 108) | 114.67 | 29.13 | 65 | 230 | 5 | 90 | 12 | 1 | MIS 10-9-8 | Dale 2022 | Bridgland 1994 |
| Corfe Mullen (*n* = 133) | 121.02 | 27.45 | 55 | 182 | 5 | 108 | 20 | - | MIS 13 | Marshall *et al*. 2002 | McNabb *et al*. 2012 |
| Cuxton (*n* = 177) | 124.76 | 39.04 | 67 | 307 | 11 | 130 | 32 | 4 | MIS 9-8 | Wenban-Smith 2004; Dale 2022 | Bridgland 2003 |
| Dovercourt (*n* = 117) | 92.71 | 28.17 | 44 | 179 | 44 | 68 | 5 | - | MIS 11 | White 1996 | Bridgland *et al*. 1990 |
| Dunbridge (*n* = 97) | 113.46 | 28.72 | 70 | 195 | 9 | 78 | 10 | - | MIS 10-9-8 | Dale 2022 | Harding *et al*. 2012 |
| Elveden (*n* = 68) | 106.59 | 25.70 | 62 | 195 | 11 | 52 | 5 | - | MIS 11 | White 1996 | Ashton *et al*. 2005 |
| Farnham (Terrace C) (*n* = 26) | 110.35 | 25.84 | 58 | 154 | 4 | 21 | 1 | - | MIS 10-9-8 | Dale 2022 | Bridgland & White 2018 |
| Fordwich (*n* = 137) | 143.69 | 25.55 | 71 | 217 | 1 | 77 | 59 | - | MIS 15 | White 1996 | Key *et al*. 2022 |
| Foxhall Road (*n* = 32) | 83.91 | 20.93 | 58 | 147 | 7 | 9 | - | - | MIS 11 | White 1996 | White & Plunkett 2004 |
| Furze Platt (*n* = 500) | 124.59 | 30.18 | 65 | 323 | 12 | 396 | 87 | 5 | MIS 10-9-8 | MacRae 1987; Dale 2022 | Bridgland 1994 |
| High Lodge (*n* = 67) | 111.85 | 30.08 | 64 | 194 | 6 | 54 | 7 | - | MIS 13 | White 1996 | Ashton *et al*. 1992 |
| Highlands Farm (*n* = 79) | 105.26 | 25.13 | 56.5 | 183 | 14 | 60 | 5 | - | MIS 13 | Lee 2001 | Wymer 1999 |
| Hillingdon L.B. (*n* = 105) | 125.17 | 39.43 | 60 | 239 | 9 | 75 | 14 | 7 | MIS 10-9-8 | Juby 2011; Dale 2022 | Ashton *et al*. 2003; Scott 2010 |
| Hitchin (*n* = 64) | 116.14 | 33.68 | 59 | 189 | 7 | 44 | 13 | - | MIS 11 | White 1996 | Boreham & Gibbard 1995; Sherriff *et al*. 2021 |
| Iver (*n* = 139) | 108.09 | 28.75 | 53 | 207 | 24 | 105 | 10 | - | MIS 10-9-8 | Dale 2022 | Bridgland 1994 |
| Kempston (*n* = 120) | 100.68 | 21.26 | 66 | 180 | 15 | 102 | 3 | - | MIS 10-9-8 | Dale 2022 | Boreham *et al*. 2010 |
| Keswick (*n* = 24) | 150.96 | 36.16 | 98 | 245 | - | 13 | 10 | 1 | ?MIS 9 | Dale 2022 | Wymer 1985, 1999 |
| Lent Rise (*n* = 108) | 110.52 | 22.08 | 69 | 172 | 6 | 96 | 6 | - | MIS 10-9-8 | Dale 2022 | Bridgland 1994 |
| Leyton and Leytonstone (*n* = 72) | 110.01 | 27.19 | 61 | 175 | 9 | 56 | 7 | - | MIS 10-9-8 | Dale 2022 | Green *et al*. 2004, 2006 |
| Lower Clapton (*n* = 42) | 101.14 | 22.98 | 69 | 181 | 7 | 33 | 2 | - | MIS 10-9-8 | Dale 2022 | Green *et al*. 2004, 2006 |
| Reculver (*n* = 68) | 115.34 | 36.55 | 62 | 233 | 6 | 49 | 12 | 1 | MIS 10-9-8 | Dale 2022 | Bridgland *et al*. 1998;  Knowles in press |
| Romsey (*n* = 1) | 235.00 | - | - | - | - | - | - | 1 | MIS 10-9-8 | MacRae 1987 | Westaway *et al*. 2006 |
| Ruscombe (*n* = 88) | 129.40 | 27.45 | 78 | 226 | 1 | 70 | 16 | 1 | MIS 10-9-8 | Dale 2022 | Wymer 1968; Bridgland 1994 |
| Seven Kings (*n* = 1) | 238.00 | - | - | - | - | - | - | 1 | MIS 10-9-8 | Taylor 2019 | Taylor 2019 |
| Shrub Hill (*n* = 1) | 285.00 | - | - | - | - | - | - | 1 | MIS 13 | MacRae 1987 | Boreham *et al*. 2010 |
| Sonning (*n* = 10) | 140.70 | 53.12 | 82 | 266 | - | 6 | 3 | 1 | ?MIS 9 | MacRae 1987; Dale 2022 | Westaway *et al*. 2006 |
| South Acre (*n* = 2) | 174.50 | 3.50 | 171 | 178 | - | - | 2 | - | MIS 10-9-8 | Dale 2022 | Boreham *et al*. 2010 |
| Stanton Harcourt (*n* = 1) | 269.00 | - | - | - | - | - | - | 1 | MIS 6 | MacRae 1987 | Bridgland 1994; Buckingham *et al*. 1996 |
| Stoke Newington\*\* (*n* = 232) | 91.68 | 22.75 | 45 | 198 | 79 | 149 | 4 | - | MIS 10-9-8 | Dale 2022 | Green *et al*. 2004, 2006 |
| Sturry (*n* = 1) | 245.00 | - | - | - | - | - | - | 1 | ?MIS 9 | Knowles in press | Bridgland *et al*. 1998; Knowles in press |
| Swanscombe\*\*\* (*n* = 121) | 92.96 | 28.01 | 45 | 259 | 40 | 77 | 3 | 1 | MIS 11 | Lacaille 1960; White 1996 | Bridgland 1994 |
| Thetford (*n* = 59) | 127.00 | 30.32 | 76 | 224 | 1 | 45 | 12 | 1 | MIS 10-9-8 | Dale 2022 | Boreham *et al*. 2010 |
| Twydall (*n* = 40) | 121.38 | 36.32 | 70 | 203 | 5 | 25 | 10 | - | MIS 10-9-8 | Dale 2022 | Bridgland 2003; Beresford 2018 |
| Wansunt (*n* = 34) | 88.65 | 17.00 | 55 | 133 | 9 | 25 | - | - | MIS 11 | White 1996 | Bridgland 1994 |
| Warren Hill (*n* = 337) | 98.67 | 29.07 | 50.27 | 260 | 91 | 224 | 21 | 1 | MIS 13 | Marshall *et al*. 2002 | Ashton & Davis 2021 |
| Warsash (*n* = 148) | 134.95 | 37.59 | 60 | 262 | 6 | 95 | 43 | 4 | MIS 10-9-8 | Dale 2022 | Davis *et al*. 2016 |
| Whitlingham (*n* = 117) | 120.91 | 38.05 | 64 | 265 | 10 | 83 | 22 | 2 | ?MIS 9 | White 1996 | Wymer 1985, 1999 |
| Wolvercote (*n* = 40) | 114.48 | 41.67 | 46 | 244 | 6 | 28 | 5 | 1 | MIS 10-9-8 | MacRae 1987; White 1996 | Bridgland 1996 |
|  |  |  |  | **Total** | **514** | **3036** | **568** | **42** |  |  |  |

Map

Description automatically generated

*Figure S1. Locations of the sites under study. Map by Frederick Foulds. (Map sources: ESRI, GTOPO30, Shuttle Radar Topography Mission (SRTM), and National Elevation Data (NED) data from the USGS).*

**2. Methods**

*Length data*

Length data for the 4160 handaxes under study were compiled from a number of sources (see Table S1). In all cases, only handaxes described or identified as complete and unbroken were selected for analysis. Linear measurements taken by the authors were produced using callipers or from scaled digital photographs. Where sourced from other published material, these sources were selected with the criteria that they employed comparable methods. The maximum length measurement was defined as the maximum distance from the butt to the tip parallel to the long axis of the handaxe, as per Roe (1968).

*Typology*

Handaxes were divided into four categories using terminology after Wymer (1968): cleavers, pointed forms, ovate forms and ficrons.

*Symmetry data*

Symmetry data were generated for 2988 handaxes within the wider dataset using Hardaker and Dunn’s (2005) FlipTest (v0.9). This freeware programme provides a graphical and numerical measure of bilateral symmetry by ‘flipping’ two-dimensional images of artefacts about their long axis and measuring the difference in pixels between the two sides. Images can be auto- or manually rotated to obtain the best readings. The results express planform symmetry as an Index of Asymmetry, with lower scores indicating greater planform symmetry. The Index of Asymmetry values can be grouped into a number of classes as follows: Class 1, virtually perfect symmetry (1.0–1.49); Class 2, very high symmetry (1.5–2.99); Class 3, high symmetry (3.0–3.99); Class 4, moderate symmetry (4.0–4.99); Class 5, low symmetry (5.0–5.99); and Class 6, very low symmetry (>6).

**3. Length analysis**

Currently, there is no standardised definition for what constitutes a giant handaxe that applies to the Acheulean as a whole. Rather, overlarge oddities that fall well out of the standard range within an assemblage are highlighted as being ‘giant’. R.J. MacRae’s (1987) ‘The great giant handaxe stakes’, which in part prompted the current study, lists those handaxes as being over 235mm in length, this being the length of the giant from Romsey, ranked the seventh largest in Britain at the time of writing following the insertion of the Stanton Harcourt handaxe into the mix. Wenban-Smith (2004), in discussing two ‘giants’ from Cuxton, presents a ficron measuring 307mm in length—a clearly giant form and the second largest in Britain—while the giant cleaver presented alongside it measures only 179mm long—large, but by no means amongst the largest bifacial forms. The range in variation as to what has previously been classified as giant is thus large.

In order to provide a statistically robust definition to classify giants within our dataset, we created a histogram displaying the frequency of handaxes separated into 10mm bins (see Figure 1 in the main text). This indicates that the largest handaxes within our sample generally fell outside the range of the normal distribution at around 220mm. Given the mean length of the sample was 115mm, with a standard deviation (SD) of ±34mm, a cut off for what can be described as a giant handaxe appears to fall around three SD above the mean. We used this as a basis to create a series of size classes into which we group the dataset. We take ‘average’ size handaxes as those that fall within one SD either side of the mean. ‘Large’ and ‘small’ handaxes are those that fall between one and three SD above and below the mean, respectively. ‘Giant’ handaxes include those that fall above three SD of the mean. In each case, we round the boundaries of these groups to the nearest 10mm. While this approach should also include a ‘miniature’ class that includes handaxes that are smaller than three SD below the mean, this would include only those handaxes smaller than 10mm, of which none are currently known.

**Table S2. Handaxe length categories used in the analysis.**

|  |  |
| --- | --- |
| **Length (mm)** | **Category** |
| <80mm | Small |
| 80–150mm | Average |
| 150–220mm | Large |
| >220mm | Giant |

Grouping our dataset using the above categories reveals a total of 42 handaxes that can be classified as giants (see Tables 1 and 2 in main text), the majority of which are pointed or ficron in form and can be dated to the MIS 10-9-8 climatic cycle.

A one-way analysis of variance (ANOVA) demonstrated that there is a statistically significant difference in the raw length measurements of handaxes between MIS 15, 13, 11 and 9 (*F*(2) = 104.7, *p* = <.001; N.B. the Stanton Harcourt giant was removed from this analysis). A Tukey post-hoc analysis indicates that there is a statistically significant pairwise difference in length measurements between all the MIS stages under analysis, suggesting a general decrease in handaxe size from MIS 15 to MIS 11 before it increases again in MIS 9 (Table S3). The reasons behind this non-directional pattern are currently unclear and further analysis is required to understand fully the factors that may underpin this apparent shift in handaxe size between the various interglacial periods. Average difference in mean length between the various MIS stages is, however, small. In addition, while MIS 15 appears to contain the on average the largest handaxes, our MIS 15 sample is restricted. Therefore, we are cautious in suggesting that that there is a trend in decreasing handaxe length between MIS 15 and MIS 11 and further data is required to prove whether this pattern is real—see discussion in main text.

**Table S3. Results of a TukeyHSD post-hoc analysis to determine pairwise differences in handaxe length measurements (in mm) between MIS 15, 13, 11 and 9.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pairwise comparison** | **Difference** | **Lower** | **Upper** | ***p* adjusted** |
| MIS 15-MIS 11 | 37.994 | 30.682 | 45.307 | <.001 |
| MIS 15-MIS 13 | 27.032 | 20.080 | 33.984 | <.001 |
| MIS 13-MIS 11 | 10.962 | 5.909 | 16.016 | <.001 |
| MIS 9-MIS 15 | -16.251 | -22.629 | -9.874 | <.001 |
| MIS 9-MIS 13 | 10.781 | 7.211 | 14.350 | <.001 |
| MIS 9-MIS 11 | 21.743 | 17.515 | 25.971 | <.001 |

**4. Symmetry analysis**

Of the 4160 handaxes within the dataset, symmetry data was generated for a subset of 2988 artefacts (Table S4). The majority of the data for MIS 9 were produced by Dale (2022). Additional data for sites dating to MIS 15–9 was sourced from analyses conducted by White and Foulds (2018). Symmetry data for handaxes classified as giants were only available for MIS 9, which thus forms the primary focus of the main text.

**Table S4. Assemblages used as part of the symmetry analysis, including frequency of handaxes within each symmetry class.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Symmetry Class** | | | | | | |
| **Site** | **Date** | **1** | **2** | **3** | **4** | **5** | **6** | **Total** |
| Acton (*n* = 6) | MIS 10-9-8 |  | 1 |  | 3 | 1 | 1 | 6 |
| Baker's Farm (*n* = 30) | MIS 9 |  | 6 | 7 | 5 | 7 | 5 | 30 |
| Barnham Heath (*n* = 82) | MIS 10-9-8 |  | 9 | 18 | 15 | 13 | 27 | 82 |
| Biddenham (*n* = 107) | MIS 10-9-1 |  | 17 | 25 | 16 | 18 | 31 | 107 |
| Bowman's Lodge (*n* = 29) | MIS 11 | 1 | 13 | 8 | 2 | 1 | 4 | 29 |
| Boxgrove (*n* = 81) | MIS 13 | 5 | 38 | 23 | 9 | 4 | 2 | 81 |
| Canterbury West (*n* = 17) | MIS 10-9-8 | 1 | 8 | 3 | 2 | 3 |  | 17 |
| Cookham (*n* = 94) | MIS 10-9-8 |  | 7 | 19 | 19 | 19 | 30 | 94 |
| Cuxton (*n* = 175) | MIS 9-8 |  | 19 | 24 | 32 | 25 | 75 | 175 |
| Dovercourt (*n* = 19) | MIS 11 |  | 8 | 4 | 4 | 2 | 1 | 19 |
| Dunbridge (*n* = 85) | MIS 10-9-8 |  | 19 | 20 | 20 | 13 | 13 | 85 |
| Elveden (*n* = 64) | MIS 11 | 2 | 34 | 11 | 9 | 6 | 2 | 64 |
| Farnham (*n* = 26) | MIS 10-9-8 |  | 7 | 5 | 3 | 2 | 9 | 26 |
| Fordwich (*n* = 136) | MIS 15 | 1 | 29 | 32 | 35 | 20 | 19 | 136 |
| Foxhall Road - Grey Clay (*n* = 16) | MIS 11 |  | 5 | 5 | 1 | 2 | 3 | 16 |
| Foxhall Road - Red Gravel (*n* = 16) | MIS 11 |  | 5 | 2 | 2 | 2 | 5 | 16 |
| Furze Platt (*n* = 463) | MIS 10-9-8 | 1 | 80 | 102 | 98 | 80 | 102 | 463 |
| High Lodge (*n* = 66) | MIS 13 |  | 38 | 11 | 7 | 3 | 7 | 66 |
| Hillingdon L.B. (*n* = 5) | MIS 10-9-8 |  |  | 2 |  |  | 3 | 5 |
| Hitchin (*n* = 63) | MIS 11 | 2 | 19 | 17 | 6 | 9 | 10 | 63 |
| Iver (*n* = 139) | MIS 10-9-8 | 1 | 14 | 19 | 38 | 27 | 40 | 139 |
| Kempston (*n* = 119) | MIS 10-9-8 |  | 13 | 27 | 33 | 16 | 30 | 119 |
| Keswick (*n* = 23) | ?MIS 9 |  | 12 | 3 | 3 | 3 | 2 | 23 |
| Lent Rise (*n* = 108) | MIS 10-9-8 |  | 4 | 20 | 28 | 20 | 36 | 108 |
| Leyton and Leytonstone (*n* = 70) | MIS 10-9-8 |  | 13 | 24 | 9 | 18 | 6 | 70 |
| Lower Clapton (*n* = 42) | MIS 10-9-8 |  | 6 | 9 | 15 | 2 | 10 | 42 |
| Reculver (*n* = 68) | MIS 10-9-8 |  | 23 | 17 | 12 | 7 | 9 | 68 |
| Ruscombe (*n* = 88) | MIS 10-9-8 |  | 15 | 22 | 23 | 15 | 13 | 88 |
| Sonning (*n* = 8) | ?MIS 9 |  | 3 | 3 | 2 |  |  | 8 |
| South Acre (*n* = 2) | MIS 10-9-8 |  | 1 |  |  | 1 |  | 2 |
| Stoke Newington (*n* = 232) | MIS 10-9-8 |  | 23 | 48 | 48 | 38 | 75 | 232 |
| Swanscombe UMG (*n* = 110) | MIS 11 | 1 | 25 | 16 | 24 | 16 | 28 | 110 |
| Thetford (*n* = 21) | MIS 10-9-8 |  | 5 | 7 | 5 | 3 | 1 | 21 |
| Twydall (*n* = 40) | MIS 10-9-8 |  | 8 | 12 | 11 | 2 | 7 | 40 |
| Wansunt (*n* = 34) | MIS 11 |  | 16 | 7 | 6 | 2 | 3 | 34 |
| Warsash (*n* = 148) | MIS 10-9-8 |  | 43 | 39 | 27 | 13 | 26 | 148 |
| Whitlingham (*n* = 117) | ?MIS 9 |  | 38 | 32 | 20 | 19 | 8 | 117 |
| Wolvercote (*n* = 39) | MIS 10-9-8 |  | 10 | 8 | 4 | 10 | 7 | 39 |
| **Total** |  | **15** | **634** | **651** | **596** | **442** | **650** | **2988** |

We first explored whether there was a correlation between raw length measurements and Index of Asymmetry scores for the handaxes in each MIS stage, with the expectation that as length increased, Index of Asymmetry scores would be lower, thus indicating increased symmetry. A Pearson’s correlation indicated that there was a statistically significant, very weak correlation between these values in MIS 9 and, to a lesser extent, MIS 11, while there was no statistically significant correlation in MIS 15 nor MIS 13 (Table S5).

**Table S5. Results of a Pearson’s correlation carried out on the raw length measurements and Index of Asymmetry scores, and the results of a one-way ANOVA carried out to determine differences between Index of Asymmetry scores between length classes.**

|  |  |  |
| --- | --- | --- |
| **Period** | **Pearson's correlation** | **One-way ANOVA** |
| MIS 15 | *r*(134) = −.11, *p* = .22 | *F*(2) = 0.89, *p* = 0.4 |
| MIS 13 | *r*(209) = .09, *p* = .28 | *F*(2) = 0.72, *p* = 0.5 |
| MIS 11 | *r*(349) = −.13, *p =* 0.02 | *F*(2) = 3.8, *p* = <.05 |
| MIS 9 | *r*(2352) = −.16, *p* = <.001 | *F*(2) = 14.13, *p* = <.001 |

We then explored whether grouping the handaxes by the proposed size categories revealed any insights into differences in symmetry between large and giant handaxes and those classified as average and small. A one-way ANOVA revealed that there was a statistically significant difference in Index of Asymmetry scores for the different length categories in both MIS 9 and MIS 11, but not in MIS 15 or 13 (Table S5).

In order to identify which differences between the size classes are significant, a Tukey post-hoc test was performed for both the MIS 11 and MIS 9 results. For MIS 9, both the large and giant classes display statistically significant pairwise differences to the small and average classes, with the average difference in each case indicating that as size increases there is a statistically significant decrease in Index of Asymmetry score (and thus an increase in symmetry) (Table S6). In addition, there was a statistically significant pairwise difference between the large and giant classes, with the average difference again indicating an increase in symmetry as handaxes increased in size. However, no statistically significant difference was found between the small and average classes. A similar pattern is observed for MIS 11, with statistically significant differences in Index of Asymmetry scores between the large size class and both the average and small classes, while no statistically significant difference occurs between the average and small classes (Table S7).

**Table S6. Results of a TukeyHSD post-hoc test to determine pairwise differences in Index of Asymmetry scores between the length classes for MIS 9 handaxes.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pairwise comparison** | **Difference** | **Lower** | **Upper** | ***p* adjusted** |
| Small-Average | 0.002 | -0.325 | 0.330 | 1.000 |
| Small-Large | 0.627 | 0.222 | 1.033 | 0.000 |
| Small-Giant | 1.807 | 0.467 | 3.148 | 0.003 |
| Large-Average | -0.625 | -0.917 | -0.333 | 0.000 |
| Giant-Average | -1.805 | -3.115 | -0.494 | 0.002 |
| Large-Giant | 1.180 | -0.152 | 2.512 | 0.104 |

**Table S7. Results of a TukeyHSD post-hoc test to determine pairwise differences in Index of Asymmetry scores between the length classes for MIS 11 handaxes.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pairwise comparison** | **Difference** | **Lower** | **Upper** | ***p* adjusted** |
| Small-Average | -0.030 | -0.581 | 0.521 | 0.991 |
| Small-Large | 1.098 | 0.065 | 2.132 | 0.034 |
| Large-Average | -1.128 | -2.098 | -0.158 | 0.018 |

These results appear to suggest that there is an increase in symmetry as length increases in MIS 11 and MIS 9, whereas a similar pattern is absent from MIS 15 and 13. Further analysis is required that incorporates an increased dataset for MIS 15 and MIS 13 in order to determine whether this is real or not—see discussion in main text.

**References**

Ashton, N. & R. Davis. 2021. Cultural mosaics, social structure, and identity: The Acheulean threshold in Europe. *Journal of Human Evolution* 156: 103011. https://doi.org/10.1016/j.jhevol.2021.103011

Ashton, N., J. Cook, S.G. Lewis & J. Rose. 1992. *High Lodge. Excavations by G. de G. Sieveking 1962–68 and J. Cook 1988*. London: British Museum Press.

Ashton, N., R. Jacobi & M. White. 2003. The dating of Levallois sites in west London. *Quaternary Newsletter* 99: 25–32.

Ashton, N. *et al*. 2005. Excavations at the Lower Palaeolithic site at Elveden, Suffolk, UK. *Proceedings of the Prehistoric Society* 71: 1–61. https://doi.org/10.1017/S0079497X00000943

Beresford, F.R. 2018. Palaeolithic material from Lower Twydall chalk pit in Kent: the Cook and Killick collection. *Lithics* 39: 20–35.

Boreham, S. & P.L. Gibbard. 1995. Middle Pleistocene Hoxnian Stage interglacial deposits at Hitchin, Hertfordshire, England. *Proceedings of the Geologists’ Association* 106: 259–70. https://doi.org/10.1016/S0016-7878(08)80237-4

Boreham, S. *et al*. 2010. The Quaternary history of the Wash fluvial network, UK. *Proceedings of the Geologists’ Association* 121: 393–409. https://doi.org/10.1016/j.pgeola.2010.02.003

Bridgland, D.R. 1994. *Quaternary of the Thames*. London: Chapman & Hall.

– 1996. Quaternary river terrace deposits as a framework for the Lower Palaeolithic record, in C. Gamble & A.J. Lawson (ed.) *The English Palaeolithic reviewed*: 24–39. Wessex: Trust for Wessex Archaeology.

– 2003. The evolution of the River Medway, S.E. England, in the context of Quaternary palaeoclimate and the Palaeolithic occupation of NW Europe. *Proceedings of the Geologists’ Association* 114: 23–48. https://doi.org/10.1016/S0016-7878(03)80026-3

Bridgland, D.R. & M.J. White. 2018. The Farnham river terrace staircase: an optimal record of the Thames Palaeolithic. *Earth Heritage* 49: 51–54.

Bridgland, D.R., P.L Gibbard & R.C. Preece. 1990. The geology and significance of the interglacial sediments at Little Oakley, Essex. *Philosophical Transactions of the Royal Society of London B*238: 307–39*.* https://doi.org/10.1098/rstb.1990.0115

Bridgland, D.R., D.H. Keen, D.C. Schreve & M.J. White. 1998. Summary dating and correlation of the Stour sequence, in J.B. Murton *et al*. (ed.) *The Quaternary of Kent and Sussex: field guide*: 53–54. London: Quaternary Research Association.

Buckingham, C.M., D.A. Roe & K. Scott. 1996. A preliminary report on the Stanton Harcourt channel deposits (Oxfordshire, England): geological context, vertebrate remains and Palaeolithic stone artefacts*. Journal of Quaternary Science* 11: 397–415. https://doi.org/10.1002/(SICI)1099-1417(199609/10)11:5%3C397::AID-JQS261%3E3.0.CO;2-M

Dale, L.C. 2022. Early Neanderthal social and behavioural complexity during the Purfleet interglacial: handaxes in the latest Lower Palaeolithic. Unpublished PhD dissertation, Durham University.

Davis, R. *et al.* 2016. The Palaeolithic record of Warsash, Hampshire, UK: implications for late Lower and early Middle Palaeolithic occupation history of Southern Britain. *Proceedings of the Geologists’ Association* 127: 558–74. https://doi.org/10.1016/j.pgeola.2016.09.005

– 2021. Palaeolithic archaeology of the Bytham River: human occupation of Britain during the early Middle Pleistocene and its European context. *Journal of Quaternary Science* 36: 526–46. https://doi.org/10.1002/jqs.3305

Green, C.P., P.L. Gibbard & B.J. Bishop. 2004. Stoke Newington: geoarchaeology of the Palaeolithic ‘floor’. *Proceedings of the Geologists’ Association* 115: 193–208. https://doi.org/10.1016/S0016-7878(04)80001-4

Green, C.P. *et al*. 2006. Marine Isotope Stage 9 environments of fluvial deposits at Hackney, north London, UK. *Quaternary Science Reviews* 25:89–113.

Hardaker, T. & S. Dunn. 2005. The Flip Test - a new statistical measure for quantifying symmetry in stone tools. *Antiquity* Project Gallery 79(306). Available at: https://www.antiquity.ac.uk/projgall/hardaker306/ (accessed 16 March 2023).

Harding, P. *et al*. 2012. Chronology of the Lower and Middle Palaeolithic in NW Europe: developer-funded investigations at Dunbridge, Hampshire, southern England. *Proceedings of the Geologists’ Association* 123: 584–607. https://doi.org/10.1016/j.pgeola.2012.03.003

Hosfield, R.T. & C.P. Green. 2013. *Quaternary history and palaeolithic archaeology in the Axe Valley at Broom, South West England*. Oxford: Oxbow.

Juby, C. 2011. London before London: reconstructing a Palaeolithic landscape. Unpublished PhD dissertation, University of London.

Key, A.J. *et al.* 2022. On the earliest Acheulean in Britain: first dates and in-situ artefacts from the MIS 15 site of Fordwich (Kent, UK). *Royal Society Open Science* 9: 211904. https://doi.org/10.1098/rsos.211904

Knowles, P.G. In press. A magnificent ficron and assemblage containing cleavers from Canterbury: a reanalysis of the collection of Dr Thomas Armstrong Bowes and a problem of provenance. *Lithics.*

Lacaille, A.D. 1960. Massive Acheulean implements from Thames and Solent gravels. *Man* 60: 103–4.

Lee, H.W. 2001. *A study of Lower Palaeolithic stone artefacts from selected sites in the Upper and Middle Thames Valley, with particular reference to the R.J. MacRae collection.* (British Archaeological Reports British Series 319)*.* Oxford: BAR.

MacRae, R.J. 1987. The great giant handaxe stakes. *Lithics* 8: 15–17.

Marshall, G.D., C.G. Gamble, D.A. Roe & D. Dupplaw. 2002. Acheulian biface database. York: Archaeology Data Service. Available at: http://archaeologydataservice.ac.uk/archives/view/bifaces/bf\_query.cfm (accessed 5 March 2021).

McNabb, J., R. Hosfield, K. Dearling, D. Barker, K. Strutt, J. Cole, M. Bates & P. Toms. 2012. Recent work at the Lower Palaeolithic site of Corfe Mullen, Dorset, England. *Proceedings of the Prehistoric Society* 78: 35–50. https://doi.org/10.1017/S0079497X00027092

Roberts, M.B. & S.A. Parfitt (ed.) 1999. *Boxgrove: a Middle Pleistocene hominid site at Eartham Quarry, Boxgrove, West Sussex.* London: English Heritage. https://doi.org/10.5284/1028203

Roe, D.A. 1968. British Lower and Middle Palaeolithic hand axe groups. *Proceedings of the Prehistoric Society* 34: 1–82. https://doi.org/10.1017/S0079497X00013840

Scott, R. 2010. *Becoming Neanderthal: the earlier British Middle Palaeolithic*. Oxford. Oxbow.

Sherriff, J. *et al*. 2021. Environments of the climatic optimum of MIS 11 in Britain: evidence from the tufa sequence at Hitchin, southeast England. *Journal of Quaternary Science* 36: 508–25. https://doi.org/10.1002/jqs.3303

Taylor, C.J.W. 2019. Lower Palaeolithic handaxes from Seven Kings and Leytonstone, London. *Lithics* 39: 5–19.

Wenban-Smith, F.F. 2004. Handaxe typology and Lower Palaeolithic cultural development: ficrons, cleavers and two giant handaxes from Cuxton. *Lithics* 25: 11–21.

Westaway, R., D. Bridgland & M.J. White. 2006. The Quaternary uplift history of central southern England: evidence from the terraces of the Solent River system and nearby raised beaches. *Quaternary Science Reviews* 17–18: 2212–50. https://doi.org/10.1016/j.quascirev.2005.06.005

White, M.J. 1996. Biface variability and human behaviour in the earlier Palaeolithic: a study from south-eastern England. Unpublished PhD dissertation, University of Cambridge.

– 2023. Collectors, class and conflict at the lower palaeolithic discovery at Stoke Newington, 1878-1884. *World Archaeology*. First view. https://doi.org/10.1080/00438243.2023.2170456

White, M.J. & S.J. Plunkett. 2004. *Miss Layard excavates: a Palaeolithic site at Foxhall Road, Ipswich, 1903-1905*. Liverpool: Western Academic & Specialist Press.

White, M.J. & F. Foulds. 2018. Symmetry is its own reward: on the character and significance of Acheulean handaxe symmetry in the Middle Pleistocene. *Antiquity* 92: 304–19. https://doi.org/10.15184/aqy.2018.35

Wymer J.J. 1968. *Lower Palaeolithic archaeology in Britain as represented by the Thames Valley*. London: John Baker.

– 1985. *Palaeolithic sites of East Anglia*. Norwich: Geobooks.

– 1999. *The Lower Palaeolithic occupation of Britain*. Salisbury: Trust for Wessex Archaeology & English Heritage.