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Time and Change in Mesolithic Britain *c.* 9800–3600 cal BC

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The Mesolithic has been characterised as temporally homogeneous: a period of stagnation or degeneration with hunter-gatherers focused on routine economic practices in an endlessly repeating seasonal round. Characterisation of the Mesolithic as timeless and unchanging derives in part from our current poor internal chronological resolution, which appears even more acute given the recent ground-breaking advances for chronological precision in adjacent time periods. However, these tendencies are exacerbated by a focus in Mesolithic studies on an outdated and simplified bipartite typological framework for the period, linked to a small number of well-preserved sites that come to stand for human lifeways across millennia. These approaches produce a peculiar temporal model within Mesolithic studies. We argue that we need both more accurate and precise chronologies, and narrative approaches that write stories of these people in their own emergent and uncertain times. To begin to do so, this paper presents a new chronological framework for British Mesolithic assemblages, based on collation, audit, and Bayesian modelling of radiocarbon measurements associated with particular microlith forms. With this new approach, we outline different understandings of temporality and inhabitation for the period c. *9800–3600 cal* BC*.*

Keywords: Mesolithic, typochronology, radiocarbon dating, Bayesian modelling

Over the course of its study, the Mesolithic has either been defined by stone tool technology (use of microliths and flaked rather than polished axes) or subsistence (as hunter-gatherers, in distinction to agriculturalists). These alternative definitions derive from two strands of the Mesolithic archaeological record – the ubiquitous lithics and the rare organic materials – that shape the kind of narratives it is possible to construct. Crucially, there has been an uneasy relationship between visions of Mesolithic societies based on these two types of evidence and, in particular, the kinds of temporal models they produce.

The majority of British Mesolithic evidence takes the form of stone tools and debitage; these survive in the archaeological record where organic materials do not. As a result, the initial foundations of Mesolithic research relied on lithics to generate both chronological and interpretive frameworks based on ideas of 'cultures' (eg, Clark 1932); sites with organics remained a holy grail, sought to develop richer understandings of how people lived in the past. Following discovery and excavation of organic-rich sites from the mid-20th century, a bifurcation developed in British Mesolithic research: some researchers such as Jacobi (eg. 1976; 1978a; 1978b) continued to study lithic material to understand the broad spread of Mesolithic lifeways; others focused on a handful of sites with exceptional organic preservation, even arguing that sites consisting solely of lithic material should not be excavated (Rowley-Conwy 1987).

This disciplinary history meant that the British Mesolithic was traditionally divided into two sub-periods: initially based on typological division between larger, 'simple', chronologically earlier microliths, and narrower, 'geometric' later microliths (Clark

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1932). This sub-division has subsequently taken on an interpretive validity, with an idealised set of lifeways extrapolated from a few key organic-rich sites used to generalise across the whole timeframe. Thus, a shift from an 'Early Mesolithic' lifeway based on hunting large terrestrial mammals (as at Star Carr) to a 'Late Mesolithic' lifeway based on marine adaptations (on Oronsay) (Waddington 2015) has become normalised. Understandings have been hampered by this unfortunate, but understandable, tendency to extrapolate from a small number of organic-rich sites. Sites such as Star Carr or Cnoc Coig came to represent a highly homogenised understanding of 'the Mesolithic', unchanging for millennia; in fact, these sites are highly atypical (Conneller & Schadla-Hall 2003; Conneller 2021) both for their times, and in their preservation. Such characterisations, where 'the specific is abstracted to the general' (Elliott & Griffiths 2018, 349) are clearly inadequate, both in the use of individual sites to characterise millennia, and also in their extrapolation beyond their immediate landscape context. Rather than Early Mesolithic life being focused on inland hunting of large terrestrial herbivores (Waddington 2015) and Late Mesolithic life coastal, a more detailed examination of the evidence demonstrates that coastal resources were important in the Early Mesolithic (eg, at Star Carr where the majority of surviving material resources come from the coast), while the vast majority of Late Mesolithic sites are inland and frequently upland (Conneller 2021), with significant implications for introductions of domesticated resources when Final Mesolithic tools were in use.

The rarity of organic remains and the nature of Mesolithic archaeology has had specific effects on both the creation of narrative structures and chronological sequences. The preservation of sites with suitable samples for radiocarbon chronologies is highly variable over both time and space. Chronological programmes have tended to focus on individual sites (eg, Howick, Star Carr) or organic artefact forms (eg. Elliott 2015), the former producing nuanced understandings of time at a single locale but replicating a focus on key sites.

Lithics have, since the earliest analyses, provided relative chronological frameworks with which to structure our narratives. However, in comparison with work on the adjacent Upper Palaeolithic and on the continental European Mesolithic, nuanced typological studies have been neglected. This is partly a result of disciplinary research history and partly the nature of the evidence.

The shift by Clark and his students away from stone tools from the late 1930s meant the evidence afforded by typologies was neglected before an adequate typo-chronological sequence was developed. In terms of the nature of the evidence, Mesolithic sites – in contrast to the discrete, episodic occupations of the preceding Upper Palaeolithic – tend to represent palimpsests of activity in favoured places, with microliths debris representing occupation over millennia.

We require evidence from both lithic and organic materials to understand changes and lifeways that varied over both time and space. Jacobi and Switsur (Switsur & Jacobi 1975; 1979; Jacobi 1976; 1978a; 1978b; 1980) initiated this work in the 1970s and 1980s. However, as groundbreaking as this was, particularly on the typological side, measurements were often made on bulked samples from repeatedly occupied sites providing only very impressionistic evidence for activity. Subsequently such work has provided greater clarity but focused only on specific parts of the Mesolithic (Reynier 2005; Griffiths 2014).

The unique nature of the Mesolithic evidence demands that we adopt a distinct analytic perspective; the vast majority of Mesolithic evidence comprises undated lithic scatters. We require a more precisely defined typo-chronology to allow us to situate this huge array of evidence in a new, broader narrative of change. Advances in scientific dating and analysis, coupled with the production of a refined Mesolithic typological scheme (Conneller 2021), mean we now have the tools for the first synthesis of chronological and material evidence from across the whole of the post-glacial and pre-agricultural period.

Here we develop a new method, a combined approach which integrates these evidence sources. First, we explore the overall visibility of human populations in Britain since the start of the Holocene and the first evidence for farming. Secondly, we apply a form of Bayesian inference (cf. Buck *et al*. 1996) to radiocarbon data to produce a new chronological and typological scheme for these 6000 years. Using chronometric evidence and grouped microlith forms, we discuss the viability of Early, Middle, Late, and Final Mesolithic lithic types as heuristic devices. Finally, we explore the distribution of sites with distinctive assemblages but which are undated using our new typo-chronology. While these comparisons reveal the limitations of each set of evidence, this work also emphasises the potential of this new approach. We can integrate evidence from undated sites, sites

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without organic remains, and move beyond narratives dominated by a handful of exceptional sites. In so doing we can create a fuller, more nuanced synthesis of lives in 10th–4th millennia Britain, narratives that both acknowledge and challenge the legacy in Mesolithic studies.

METHOD

Data collection

The research analyses a database of 1518 radiocarbon measurements, deposited with the Archaeological Data Service (Conneller 2025). Building on work by Weninger and colleagues (2009) which collated 347 dates from Britain, data collection ended in 2022; additional important datasets (eg, Bexhill, Donnelly *et al.* in prep.) are not yet in the public domain.

In our two analytical approaches, we interrogate results produced on terrestrial samples which are unlikely to have a significant in-built offset (excluding results on yew, oak, unidentified charcoal, or wood). We also exclude results on 'sediment' or peat, which are not easily associated with a defined anthropogenic 'archaeological event of interest' (Griffiths & Higham 2022).

The dataset is subject to several caveats: it is very uneven across time and space as a result of taphonomy, geomorphology, different regional research histories, and temporally discrete cultural practices that generate datable material. For example, Star Carr accounts for *c.* 20% of the total dataset of available short-life terrestrial samples (see Discussion). Similarly, just over half the short-life, terrestrial samples included in this analysis (n=449) were produced on hazel (nutshells, charcoal, etc). Both the over-emphasis on individual sites and over-reliance on specific types of samples need to be addressed in future research. To benefit from the full implications of the 'organics revolution' (Johnston *et al.* 2023), multiple measurements on a range of species should be made from all sites with good association between radiocarbon samples and archaeological evidence for Mesolithic activity, not just exceptional examples (see Discussion).

Analytical approaches

We have used the programme OxCal (Bronk Ramsey 2009), and the northern hemisphere calibration dataset (Reimer *et al.* 2020). Analytical code is provided in the Supplementary Material, Appendix S1. In our first approach, we have used a Kernel Density Estimation (KDE) (Bronk Ramsey 2017) to explore data trends over the very long term.

In the second, for sites with reasonable associations between radiocarbon measurements and diagnostic lithic types, we have adopted a 'site specific' approach (cf. Griffiths & Staff 2022 for types of chronometric analyses). Microlith classification was undertaken using a modified version of Jacobi's type list (Conneller 2021), using published drawings (when these were of sufficient quantity and quality, and their link with known contexts secure) or through re-recording of lithics and archive research (if drawings were lacking or associations with radiocarbon measurements uncertain from published materials). When sufficient data were present, microlith forms were grouped to define broader 'assemblage types'. Some, such as Horsham (Clark 1933), Honey Hill (Saville 1981), Star Carr, and Deepcar assemblage types (Radley & Mellars 1964) have previously been defined, others (eg, Variably Lateralised Scalene) were identified through this project. Some of these assemblages have previously been argued to have specific chronological currencies (eg, Reynier 2005), a key focus of this research therefore was to investigate the variability of forms over time using Bayesian chronological modelling across the entire period (a pilot for this project focused on Early Mesolithic forms (Conneller *et al.* 2016), while Griffiths (2014) analysed the final centuries).

Readers should note that this typo-chronology is built only on microlith form and not on other tool forms or technology. We examine how microlith forms and combinations of microlith forms vary over time, and how effective these forms are as heuristics for building wider, synthetic narratives over the whole period. In so doing, we acknowledge both the importance of lithic studies, *and* challenge the ways in which archaeologists think with these things; microlith forms are here absolutely not being used to define particular 'cultures' (*contra* Waddington *et al.* 2017). Assemblage types were defined as follows:

1. Star Carr assemblages (Fig. 1, A) have broad obliquely truncated points and large isosceles triangles and trapezes (Reynier 2005).
2. Deepcar assemblages (Fig. 1, B) have narrower, elongated, obliquely truncated points, sometimes with retouch on the leading edge, which grade into partially and fully backed forms.

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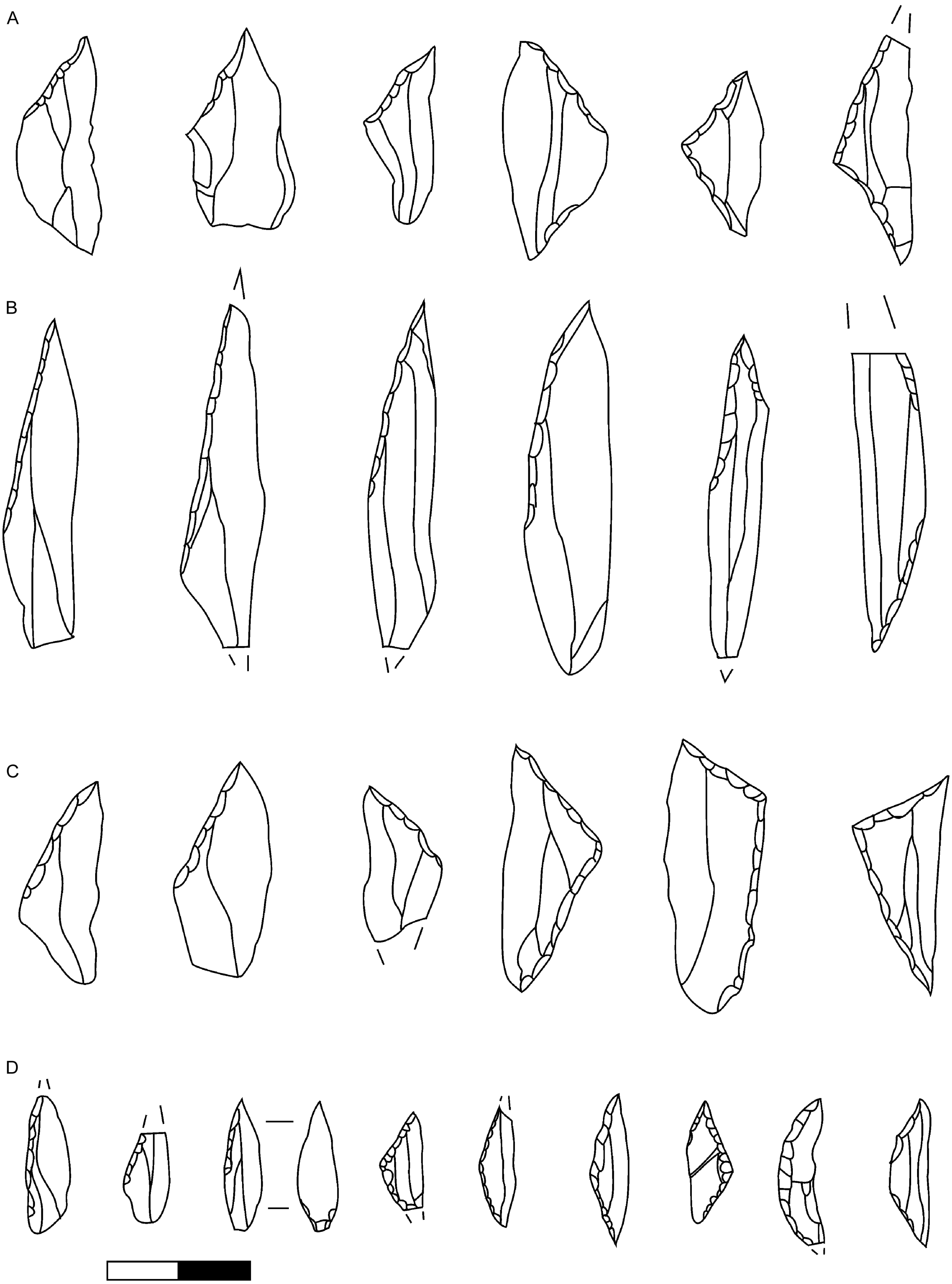

Fig. 1.
Early Mesolithic microlith forms: A. Star Carr types; B. Deepcar types; C. Nab Head types (after David 2007); D. Cramond types (after Lawson *et al*. 2023)

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Trapezes and triangles are present in reduced numbers. Rhomboids also occur, as can curve-backed pieces (Reynier 2005).

3. Nab Head assemblages (Fig. 1, C) are similar to Star Carr type assemblages and are often placed in this group, however they are characterised by the presence of obliquely blunted points and large scalene triangles (in contrast to the isosceles triangles of Star Carr assemblages).
4. Cramond types are characterised by small, predominantly left-lateralised obliquely truncated points, curve-backed pieces, and isosceles triangles (Fig. 1, D). They are currently unique to Cramond itself (Lawson *et al.* 2023), though are likely to be present among the ploughzone assemblages found along certain Scottish rivers, as isosceles triangles are recovered from these regions. The Cramond assemblage (Conneller *et al.* 2016; Conneller 2021; Ballin 2023) contains isosceles triangles rather than the narrow scalenes that define the traditionally termed 'narrow blade' microlith industries (*contra* Waddington 2015) and thus appears to be a distinct assemblage type. The Cramond assemblage also includes a Honey Hill style inversely retouched point.
5. Horsham assemblages are characterised by hollow based points and other basally modified forms (Fig. 2, A). Obliquely truncated points still dominate though and are strongly left-lateralised (>95%) (Reynier 2005). Obliquely truncated points are short and broad, more similar to Star Carr than Deepcar examples. Rhomboids are present and triangles persist, but trapezes are absent.
6. Honey Hill assemblages are distinguished by the presence of inversely retouched, basally modified pieces (5–20%) (Fig. 2, B). Obliquely truncated and partially backed points are present in varying numbers (20–60%), often with retouch on the leading edge. These are small in comparison to obliquely truncated points in Star Carr and Deepcar type assemblages. Also found within these assemblages are curve-backed pieces, lanceolates, isosceles and scalene triangles, and rhomboids. Lateralisation of obliquely blunted points is strongly to the left (>90%), scalenes can be left- or right-lateralised.
7. Variably-Lateralised Scalene (VLS) assemblages are characterised by the presence of narrow scalene triangles. While these tend to have more left-lateralised scalenes (if the microlith is orientated with the shoulder uppermost), a substantial number of right-lateralised examples are present (proportions are usually along the lines of two left- to one right-). These scalenes are accompanied by small and narrow obliquely blunted points, part-backed pieces, and sometimes backed bladelets and crescents.
8. Left-Lateralised Scalene (LLS; Fig. 3) assemblages consist of assemblages where the vast majority of scalenes are left-lateralised (usually 90–100%). These are often very small (microscalenes). They are accompanied by varying quantities of backed bladelets and crescents.
9. Microtranchet assemblages (Fig. 4, A–B) contain small numbers of symmetric or asymmetric microtranchets accompanied by larger numbers of microscalenes, backed bladelets, and crescents.
10. Four-sided assemblages (Fig. 4, C) contain small four-sided pieces or rhomboids and are accompanied by backed bladelets.
11. Rod assemblages (Fig. 4, D) are composed of regular, narrow, unusually steeply backed bladelets, which can be retouched on one or both laterals, and no other microliths.

For the site-based analyses, generally where sites produced three or more results associated with diagnostic lithics, we have applied Boundary-defined Phase models in OxCal. For the complex multi-phase sites of Star Carr (Bayliss *et al.* 2018) and Howick (Bayliss *et al.* 2007b), we have recalculated published analyses using the most recent calibration dataset and extracted relevant posterior density estimates. We provide the analyses we have created for these sites which readers should note are updated from the original publications.

Because we have only analysed results on short-life samples, that are well-associated with diagnostic lithic tool types, we only present results from some 49 sites (Table 1). We have grouped these results by types of lithic assemblages, allowing us to estimate the overall currency of Early, Middle, Late, and Final Mesolithic tool types, and to investigate potential overlap between these different forms.

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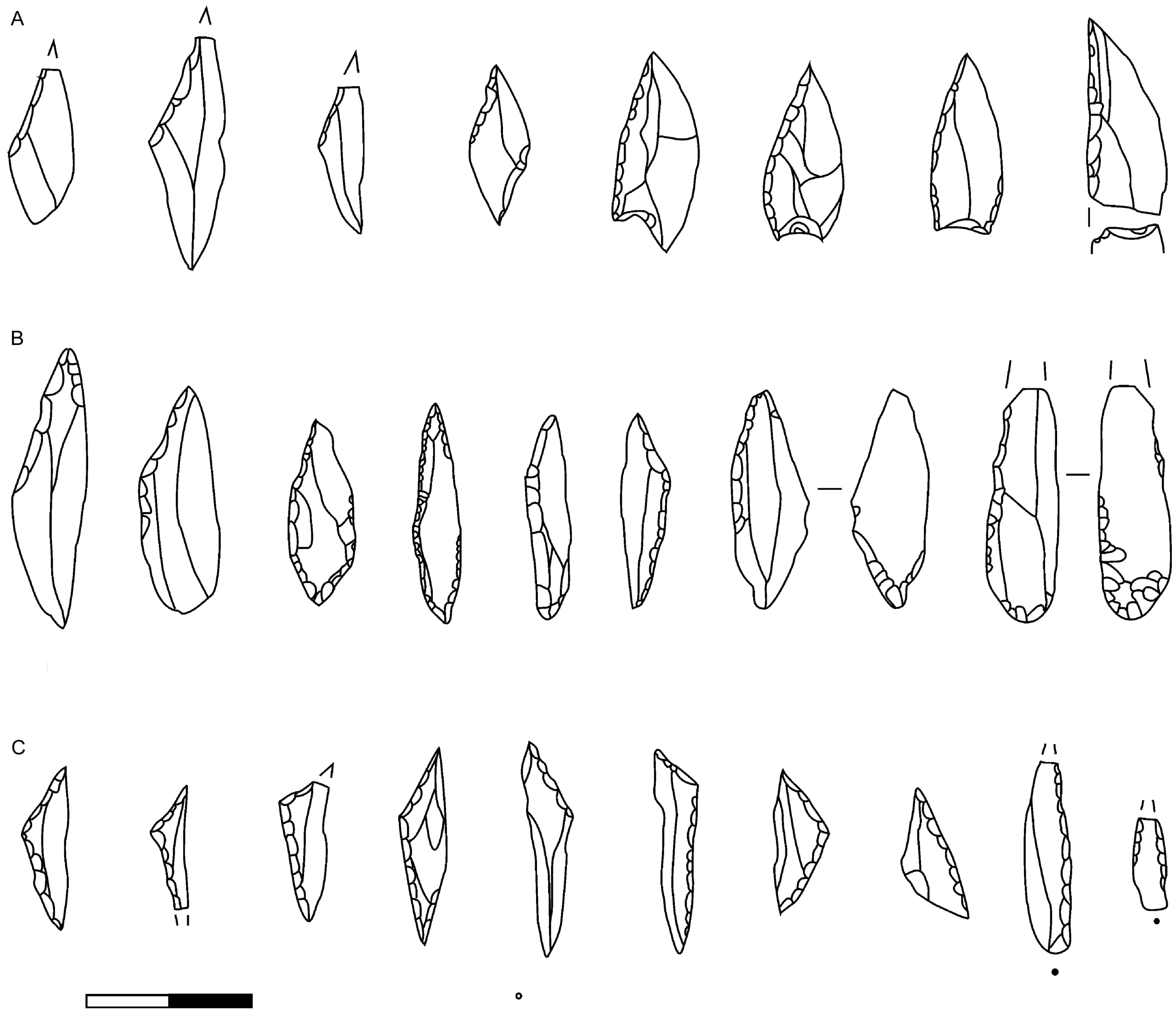

Fig. 2.
Middle Mesolithic microlith forms. A. Horsham types; B. Honey Hill microliths (after Cooper *et al.* 2017); C. Variably Lateralised Scalene microlith assemblage

The only Late Mesolithic forms we have identified that are associated with radiocarbon results are LLS type triangles. This probably under-estimates the complexity of typological variation during the later period, as several different microlith types are found in varying proportions within LLS assemblages. As we discuss below, the chronologies of Late and Final Mesolithic tool complexes are poorly understood compared with earlier types. Our Final Mesolithic forms include rod types, and microtranchet types; the majority of measurements are associated with rod type tools, which again probably belies variability in lithic forms at this time. Four-sided types may also belong to this period but the only associated measurement is on bulked, unidentified wood from Wawcott I, so has not been included in this analysis.

RESULTS

Dataset temporal distribution

Figure 5 shows results from the KDE analysis of short-life, terrestrial measurements (n=887). This approach

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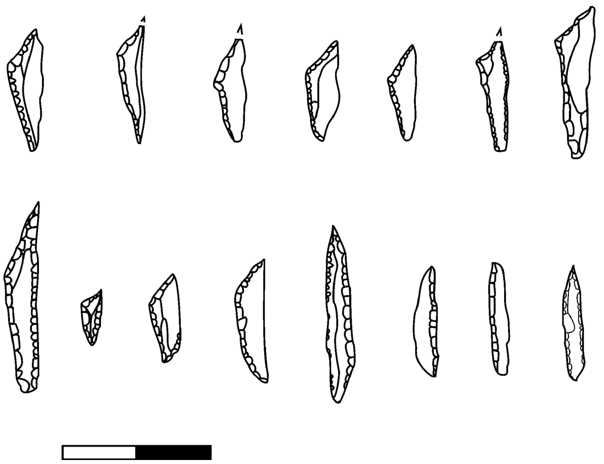

Fig. 3.
Late Mesolithic Left-Lateralised Scalene microlith assemblage

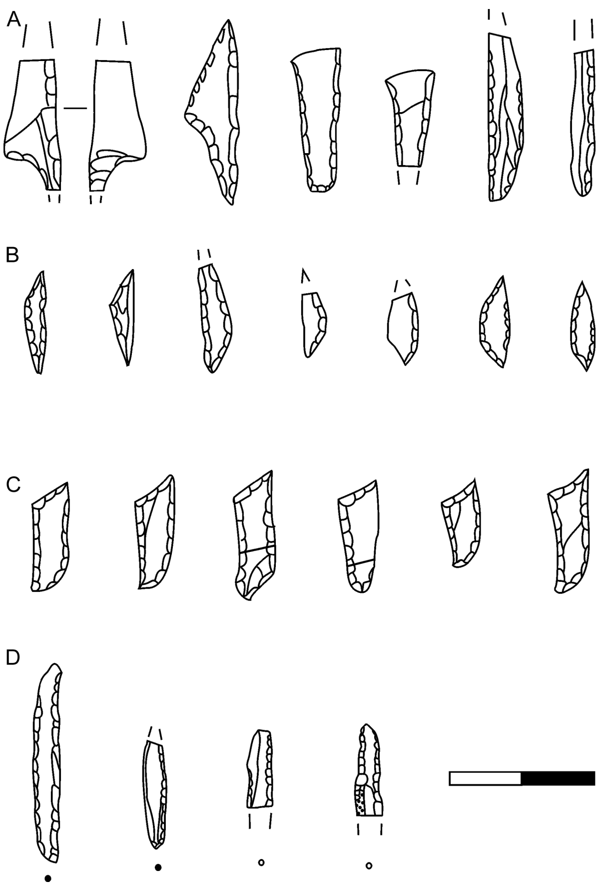

Fig. 4.
Final Mesolithic microlith types: A–B. microtranchet assemblage; C. four-sided microliths; D. rod assemblage

has the effect of reducing some of the smearing that results from the measurement uncertainty and the shape of the calibration dataset (Bronk Ramsey 2017). The peaks reflect the intensity of radiocarbon measurements over time, which may be indicative of the underlying frequency of anthropogenic activity preserved in the archaeological record.

The median is 7449 cal BC (Fig. 5). This is skewed towards the earlier part of the timeframe. We can therefore suggest that these data either sample more earlier activity, or that more earlier activity is being preserved and identified in the archaeological record and subsequently used as the basis for radiocarbon measurements. We suggest that radiocarbon measurements from earlier activity are being preferentially produced and earlier Mesolithic activity is 'better dated' generally than later Mesolithic activity (though there are important caveats on an individual site basis, see below).

Within the KDE distribution there are also notable earlier peaks *c.* 8700 cal BC, *c.* 8300 cal BC, and *c.* 7600 cal BC. There are less marked positive trends *c.* 7100 cal BC, *c.* 6700 cal BC, and *c.* 6000 cal BC. The peaks could

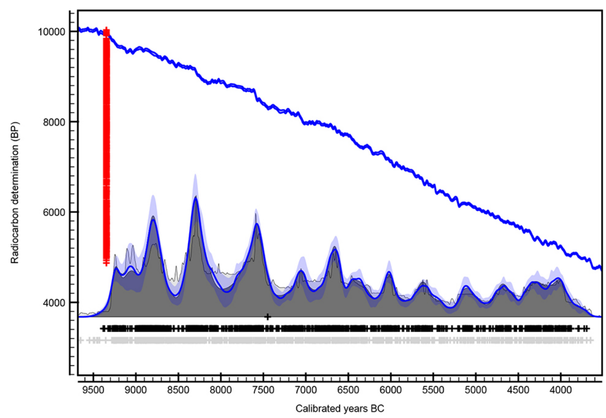

Fig. 5.
Output from a KDE analysis of radiocarbon measurements on short-life, terrestrial samples associated with anthropogenic activity. Light grey crosses show the medians of radiocarbon measurements, and the black crosses show medians of the marginal posterior distributions from the estimate. A single black cross at the bottom of the distribution indicates the median of the whole dataset. The grey distribution is the KDE, with the sum of this in outline behind. The blue line and light blue distribution represent the mean 1σ range for the KDE, and provide an indication of the importance of any features in this distribution

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TABLE 1. EARLY, MIDDLE, LATE, AND FINAL MESOLITHIC ASSEMBLAGE TYPES

Site name	*Material and associations*	*Radiocarbon measurements*	$\delta^{13}C$	*Industry name*	*Assemblage type*
Broxbourne 104	Bone with discrete lithic assemblage, sealed by early Boreal peat (Jacobi archive, British Museum)	Q-3040; 9350±120		Star Carr type	Early Mesolithic forms
Seamer C	Charcoal and humanly-modified bone associated with refitting lithic scatters (Conneller & Schadla-Hall 2003)	HAR-5238; 9300±110 HAR-5793; 9320±150 OxA-26542; 9340±45	-28.2 -28.2 -22.41		
Seamer K	Salix/populus from refitting lithic scatter, sealed by peat (Conneller & Schadla-Hall 2003)	HAR-5794; 9590±120			
Human activity at Star Carr	Various short-lived material within modelled peat sequence (223 dates in total)	See Bayliss *et al.* 2018			
Broxbourne 106	Hazel nutshell, from same thin peat as microliths (Jacobi archive, BM)	Q-1146; 9360±150		Deepcar type	
Faraday Road	Hazel nutshell from eastern occupation scatter (Ellis *et al.* 2003)	NZA-11038; 9148±60	-23.9		
Greenham Dairy Farm	Hazel nutshell from pit (Reynier 2005)	OxA-5194; 9120±80	-23.2		
Lackford Heath	Resin on flake from homogenous microlithic assemblage in hollow (Jacobi 1984)	OxA-2342; 9240±110	-29.1		
Little Holtby	Hazelnut shells from lower and upper fills of large hollow with microliths (Speed *et al.* 2018)	SUERC-67553; 9148±31 SUERC-67554; 9173±31	-23.8 -24.0		
Marsh Benham	Hazelnut shell associated with lithic scatter (Reynier 2005)	OxA-5195; 8905±80	-23.7		
Newbury Sewage works	Hazelnut shell associated with lithic scatter (Healy *et al.* 1992)	BM-2744; 9100±80	-23.3		
Oakhanger V/VII	Hazelnut shells stratified with Deepcar assemblage (Reynier 2005)	Q-1489; 9225±170			
Sanderson Site	Hazelnut shell from scatter of lithic and faunal material (Corcoran & Howell 2002)	Beta-200075; 9230±50			
Thatcham III	Resin on flake from lithic scatter (Wymer 1962, Roberts *et al.* 1998)	OxA-2848; 9200±90	-28.8		
Three Ways Wharf	Roe and red deer teeth from scatter C west (Lewis & Rackham 2011)	OxA-5557; 9280±110 OxA-5558; 9265±80 OxA-5557; 9200±75	-21.4 -23.0 -21.3		

(Continued)

TABLE 1. (CONTINUED)

Site name	*Material and associations*	*Radiocarbon measurements*	$\delta^{13}C$	*Industry name*	*Assemblage type*
Westhampnett	Hazelnut shells from upper fill of gulley with Deepcar material (Fitzpatrick *et al.* 1997)	OxA-4168; 9120±90	-22.4		
Windy Hill Farm	Hazel charcoal from hearth associated with scatter (S. Poole pers. comm.)	OxA-38628; 9203±30 OxA-38629; 9173±29	-25.57 -25.63		
Cramond	Hazelnut shells from pits and silty spread containing lithics that seals the pits (Lawson *et al.* 2023)	OxA-10143; 9150±45 OxA-10144; 9110±60 OxA-10230; 9150±50 OxA-10178; 9105±65 OxA-10179; 9130±65 OxA-10180; 9150±65	-23.5 -23.1 -24.9 -23.3 -23.9 -26.0	Cramond type	
Daylight Rock	Hazelnut shells associated with activity above cave (David 2007)	OxA-2245; 9040±90 OxA-2246; 9030±80 OxA-2247; 8850±80	-22.2 -25.0 -25.2	Nab Head type	
Nab Head	Hazel nutshells associated with scatter (David 2007)	OxA-1495; 9210±80 OxA-1496; 9110±80	-26.0 -26.0		
Asfordby	18 dates on burnt bone, probably representing hearth associated with occupation (Cooper *et al.* 2017)	see Cooper *et al.* 2017		Honey Hill type	Middle Mesolithic forms
Spong Hill	Pine from burnt layer of sand and gravel in tree throw with Honney Hill microlith (Healy 1988)	HAR7063; 8280±80			
Filpoke Beacon	Hazel nutshells from pit/hollow containing the lithic assemblage (Jacobi 1978a)	Q-1474; 8760±140		VSL type	
Howick	24 dates on charred hazel nutshells from dwelling structure	See Bayliss *et al.* 2007a for model			
Kinloch (VSL phase)	Charred hazel nutshells from AD/AJ pit fills associated with VLS microliths (Wickham Jones 1990)	OxA-1973; 8360±70 OxA-1974; 8060±150 OxA-2040; 8490±70	-24.9 -23.8 -25.1		
Lightmarsh Farm	Charred hazel nutshells from pit/hollow containing VLS assemblage (Jackson *et al.* 1994)	OxA-4327; 8800±80	-25.2		
Prestatyn (Bryn Newydd)	Charred hazel nutshells associated with flint tools, in thin black soil sealed by tufa (David 2007)	OxA-2268; 8700±100 OxA-2269; 8730±90	-23.5 -23.6		

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TABLE 1. (CONTINUED)

Site name	*Material and associations*	*Radiocarbon measurements*	$\delta^{13}C$	*Industry name*	*Assemblage type*
Snail Cave Rock Shelter	Four charred hazel nutshells and one teal bone from layers 4 and 5 of stratified rockshelter with VLS assemblage (Smith & Walker 2014)	SUERC-37670; 8870±30 SUERC-42946; 8788±31 SUERC-42947; 8862±31 SUERC-42947; 8862±31			
Netherhall Rd, Maryport	Charred hazel nutshells from phase 1 pits and phase 2b layer, associated with VLS assemblage (see also supplemental information) (Clarke *et al.* 2022)	SUERC-88677; 8863±22 SUERC-88678; 8849±24 SUERC-88679; 8905±23 SUERC-88683; 8823±20 SUERC-88685; 8952±24 SUERC-88686; 8966±24 SUERC-88687; 8970±24	-26.4 -26.3 -25.3 -24.3 -22.3 -23.4 -23.2		
Kettlebury 103	Charred hazel nutshells associated with hearth and surrounding Horsham scatter (Jacobi archive, BM)	OxA-378; 8220±120 OxA-379; 7990±120 OxA-6395; 7990±90 OxA-6396; 7890±80		Horsham type	
Longmoor I	Charred hazel nutshells from Horsham scatter (Jacobi archive, BM)	OxA376; 8930±100 OxA377; 8760±110			
North Park Farm, Bletchingly	Hearths [160] and [161] with Horsham material; stratigraphic model for hearth [160] (Jones *et al.* 2013)	OxA-16905; 8275±40 SUERC-12927; 8270±35 SUERC-13207; 8235±35 SUERC-13955; 8275±40	-25.9 -27.3 -27.1 -25.4		
Ascott-under-Wychwood	Roe deer near localised, but disturbed LLS scatter (Bayliss *et al.* 2007b)	GrA-27098; 6180±45 GrA-27099; 6000±45	-24.4 -24.2	LLS type	Late Mesolithic forms
Auchareoch	LLS within firepit in south quarry (Affleck *et al.* 1988)	OxA-1601; 8060±90	-26.0		
Bart's Shelter	Bone point from cave with LLS (Jacobi archive)	OxA-8069; 7160±60	-21.8		
Broxbourne 105	Bos tooth associated with refitting microlith production scatter in peat (Jacobi archive)	OxA-593 7230±150			
Caochanan Ruadha	Taxus twigs from pit hearth 406 associated with LLS (Warren *et al.* 2018)	SUERC-58040; 7252±30 SUERC-58041; 7259±30	-22.8 -23.2		
Falmer Stadium	Charred hazel nutshell from pit 175 containing left lateralised scalene (Garland *et al.* 2016)	SUERC-32623; 7440±40	-25.0		

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TABLE 1. (CONTINUED)

Site name	*Material and associations*	*Radiocarbon measurements*	*δ^{13}C*	*Industry name*	*Assemblage type*
Goldcliffe A	Charred hazel nutshell from same grid square as LLS manufacturing episode (Bell 2007)	OxA-13928; 6629±38	-23.3		
Lominot C	Shrubby species from stakehole associated with LLS scatter (Spikins 2002)	OxA-9645; 6090±55	-25.6		
		OxA-10210; 6085±45	-27.3		
		OxA-10211; 6070±45	-26.4		
Lón Mór	Charred hazel nutshells from organic midden, associated with LLS assemblage (Bonsall 1997)	AA8793; 7385±60	-25.0		
		AA71457; 6240±55	-27.9		
March Hill Carr	Corylus and prunus charcoal from hearths 1-4 associated with refitting LLS assemblage, sealed by peat (Spikins 2002)	OxA-6296; 5790±35	-24.4		
		OxA-6297; 5835±35	-24.4		
		OxA-6298; 5745±35	-24.6		
		OxA-6299; 5830±35	-25.3		
		OxA-6300; 5855±40	-26.0		
		UB-4050; 5813±22	-26.4		
		UB-4051; 5824±28	-26.0		
		UB-4052; 5796±29	-26.8		
Norber Cave	Stratified humanly-modified bone and antler with LLS assemblage from cave (Lord *et al.* 2016)	OxA-39459; 7734±26	-20.82		
		OxA-39460; 7951±28	-22.09		
		OxA-39461; 7768±28	-22.6		
		OxA-39462; 7642±27	-22.12		
Standingstones	Charred hazel nutshells from pits and hollows with LLS assemblage (Dingwall *et al.* 2019)	SUERC-49726; 8026±38			
		SUERC-57937; 7825±30			
		SUERC-57938; 7985±25			
		SUERC-68124; 7960±29			
		SUERC-68125; 7988±29			
		SUERC-68126; 7967±30			
Staosnaig	From context 17 of pit 24, LLS (Mithen 2000)	AA-21619; 7760±55	-24.8		
		AA-21621; 7780±55	-25.6		
		AA-21622; 7660±55	-25.7		
		AA-21623; 7665±55	-27.6		
		AA-21624; 7935±55	-25.1		
		Q-3278; 7920±110			
Stratford's Yard	Aurochs from layer XII/4 associated with microtranchets. Dating and analysis suggests *in situ* layers (XII/4–XIII/5) beneath colluviation (site archive, Bucks. Museum)	BM2404; 5890±1000		Asymmetric microtranchets	Final Mesolithic forms
Fir Tree Field Shaft	Rod microliths in layer 7	OxA-7987; 5275±50		Rod type	
Lydstep	Pig skeleton with rod microlith (Jacobi 1980)	OxA-1412; 5300±100	-21.1		

(Continued)

TABLE 1. (CONTINUED)

Site name	*Material and associations*	*Radiocarbon measurements*	*δ¹³C*	*Industry name*	*Assemblage type*
March Hill B (rod site)	Discrete rod scatter surrounding small hearth (Griffiths 2014)	OxA-6301; 5310±45	-25.5		
		OxA-6302; 5315±35	-26.1		
		OxA-6303; 5255±30	-25.1		
		OxA-6304; 5180±30	-26.5		
		OxA-6305; 5270±45	-25.6		
		OxA-6306; 5190±45	-25.3		
		UB-4053; 5271±24	-26.3		
South Haw	Pit hearth associated with rod scatter (Chatterton 2005)	Beta-189652; 5270±40	-27.1		
		Beta-189652; 5010±40	-26.8		

indicate increases in past human activity – or at least human activity preserved in the archaeological record – at these points in time. To investigate this further we have produced KDE distributions for sites with ten or more measurements; these estimates are too few for KDE distributions to provide meaningful summaries of events in terms of individual site histories, however, this approach helps us understand the impacts of research histories at individual sites on the overall impression of activity during this timeframe.

In Figure 6, we have overlain individual site KDE distributions on the KDE for the whole anthropogenic terrestrial dataset (in black) to identify whether trends are artefacts of research histories at individual sites. Most sites do not show an obvious or disproportionate impact on the KDE distribution for the timeframe. However, we can clearly see what we might term a 'Star Carr effect', when a single site dominates the signal for a whole timeframe. In this dataset, the first 1000 years of the overall distribution closely mirrors the results produced from the single site of Star Carr (red). This is hardly surprising; nearly 20% of the dataset in this analysis was from samples from Star Carr. Similarly, the positive trend focusing on *c.* 6000 cal BC in the distribution is probably overly dependent on the dataset from Bouldner Cliff (continuous yellow). Slightly less clearly, the positive trend at *c.* 6700 cal BC appears to derive from measurements from Criet Dubh (dashed magenta). The same disproportionate impact may be occurring with results from March Hill Carr (dashed red) at *c.* 4700 cal BC.

The peak at *c.* 7600 cal BC results at least in part from two positive trends in results from Howick (in continuous magenta) and Fife Ness (purple), and potentially from other sites. This trend therefore could represent a real increase in wide ranging archaeologically visible activity – beyond these individual sites – around this time.

Perhaps most interesting is the peak at *c.* 8300 cal BC, here we see broadly co-eval positive trends from several sites including: Aveline's Hole (dashed turquoise), Echline (dashed blue), Netherhall (dark orange), and Craig-Rhos-y-felin (navy blue), as well as, potentially, by trends at other sites. While these positive trends at this point in time at individual sites are not as marked, as for example the 'Star Carr effect', that this increase at *c.* 8300 cal BC, results from research across sites in different regions

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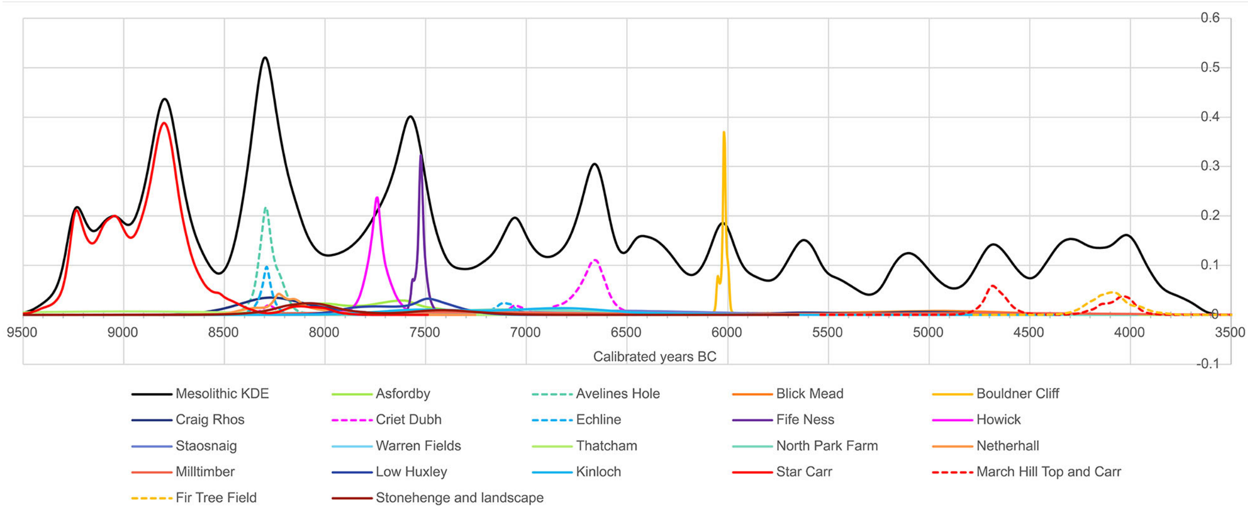

Fig. 6.
Comparison of the KDE distribution for the whole of the dataset and KDE distributions for individual sites with relatively large proportions of data

suggests a geographically wide ranging increase in human activity, or at least archaeologically visibility.

Increased evidence in the archaeological record from the 9th millennium BC has previously been related to an influx of population (Waddington 2015), but we argue it is likely to be the product of several factors, only some of which are related to past activity. First, the signal prior to the *c.* 8300 cal BC peak is dominated by the 'Star Carr effect', making it difficult to determine the previous intensity of occupation. Secondly, various Middle Mesolithic forms are first apparent in the archaeological record *c.* 8300 cal BC, suggesting more complex social practices. This included new forms of microlith, potentially indicating new forms of hafting technology (Cooper *et al.* 2017) but also new cultural practices, focused on pit digging and deposition of burnt material such as hearth sweepings. Finally, we suspect that there may be a relationship with the positive signal *c.* 8300 BC and the hazel rise and the consequent increase in the deposition of hazelnut shells in pits. From this point, hazel samples dominate the dataset; hazel nutshells are short-lived, resilient ecofacts which, critically, are easily identified, meaning that they are disproportionately preferentially selected for radiocarbon measurements. The *c.* 8300 BC peak could represent new cultural practices including pit digging and deposition, but at least part of this signal could reflect greater radiocarbon sample availability.

The much smaller positive trend focusing on *c.* 4100 cal BC at March Hill Top and Fir Tree Field, as well as potentially at other sites, could also indicate a wide ranging trend in population, activity levels, or cultural practices at this time.

Creating the typochronological scheme

Central to this research was exploring the validity of lithic forms as heuristic devices for understanding change over time and how these different forms related temporally. Early, Middle, Late, and Final forms clearly represent broadly sequential changes over the timeframe *c.* 9600–3600 cal BC (Figs 7 and 8, Table 2). Within the Early and Middle forms we have good evidence for the temporal overlap of different types.

Early Mesolithic assemblages probably first appeared in the 94th or 93rd centuries cal BC (94% probable). Of these, Star Carr forms clearly pre-date other types, first appearing at that time (99.9% probability). Deepcar industries appear later, probably in the 88th–86th centuries cal BC (62% probability). Next, we see less common (and less well dated) tool types, with the Cramond industry (85th or 84th centuries cal BC; 85% probability) and the Nab Head industry (85th or 84th centuries cal BC; 60% probability). In the second half of the 9th millennium, Deepcar, Nab Head, and Cramond

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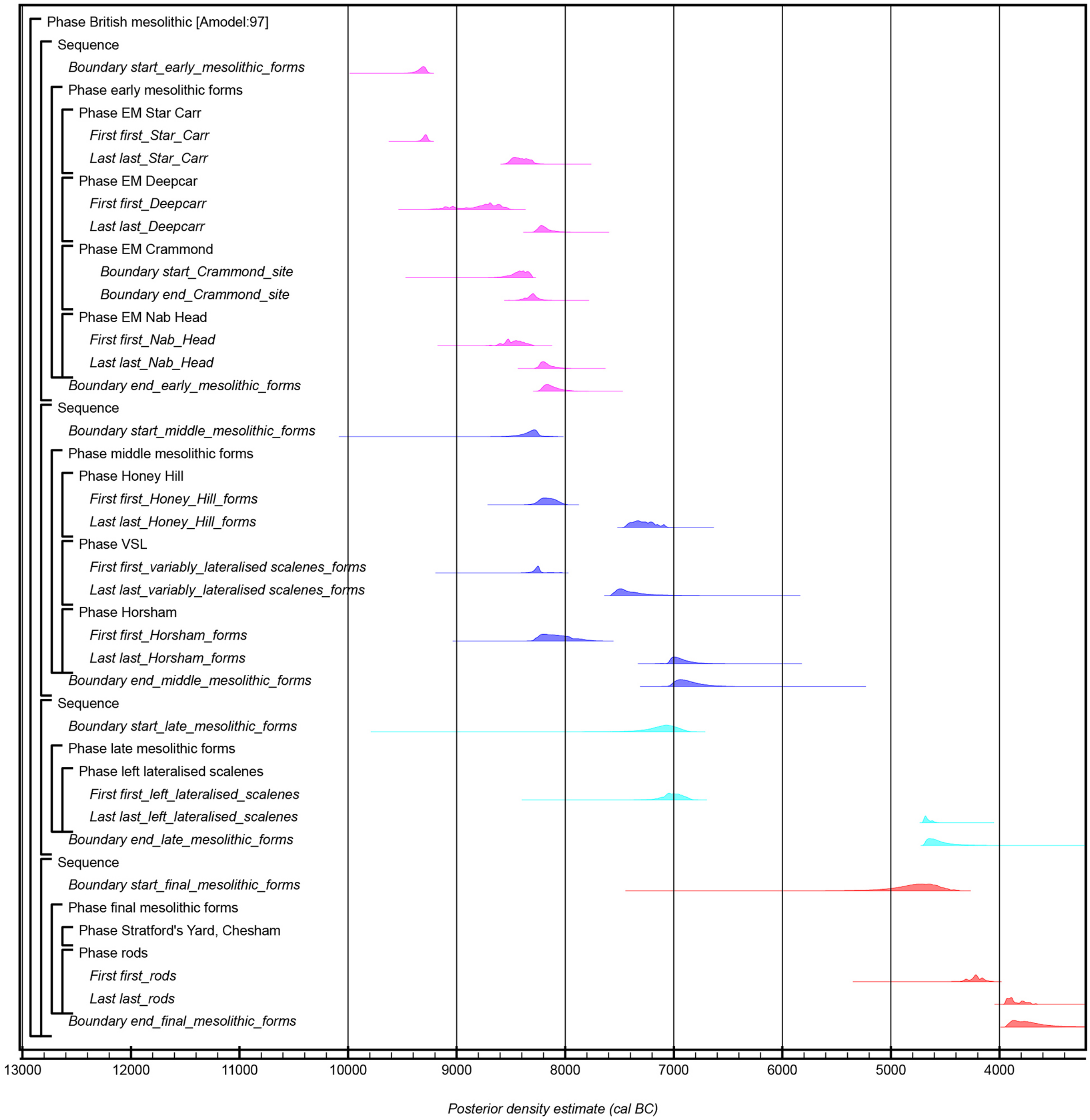

Fig. 7.
Results for analysis of radiocarbon measurements associated with diagnostic 'Early', 'Middle', 'Late', and 'Final' assemblages. The OxCal CQL2 keywords define the analysis (Appendix S1)

industries may have overlapped chronologically and appear to represent regionally varied traditions of microlith production.

Towards the end of the 9th millennium we see the appearance of contemporaneous Middle Mesolithic assemblages, from the 84th or 83rd centuries cal BC (79% probability). VLS are the earliest diagnostic forms within these assemblages, beginning to be used in the 83rd century cal BC (81% probability). Honey Hill forms first appear in the 82nd–81st centuries cal BC

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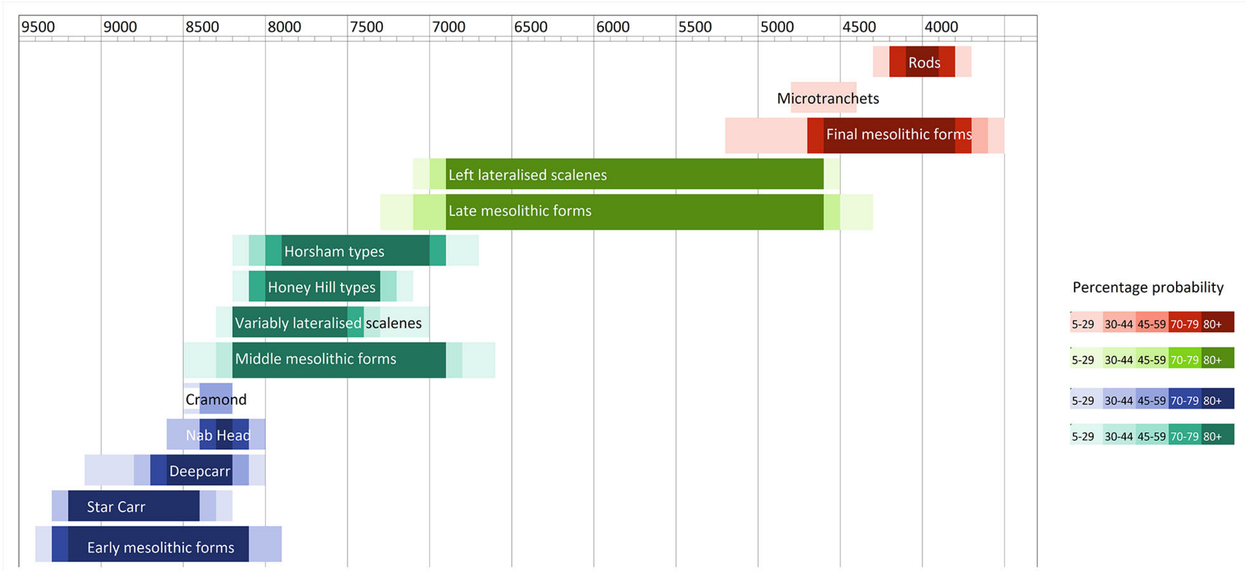

Fig. 8.
Summary of the chronological currency of Early, Middle, Late, and Final Mesolithic assemblages and their diagnostic tool types

(70% probability), while Horsham forms may first appear in the 82nd–79th centuries cal BC (70% probability).

As noted above, the appearance of Middle Mesolithic forms was co-eval with the *c.* 8300 cal BC peak; here we see regional variation in lithic forms, sites from across Britain peaking in archaeological visibility, *and* changes in practices including pit digging and deposition. While the hazel rise undoubtedly contributes, these combined evidence strands suggest important new practices and patterns in human behaviour at this time.

Late Mesolithic forms first appeared in the 72nd–70th centuries cal BC (76% probability). LLS triangles, the only diagnostic Late Mesolithic tool type associated with radiocarbon results, are present over nearly two millennia into the 5th millennium cal BC. As noted, Late and Final Mesolithic microliths are not as well dated as Early and Middle Mesolithic forms – certainly in terms of numbers of measurements and geographic spread, with possible implications for our understandings of practices associated with the use of these forms. Currently, the apparent homogeneity of Late Mesolithic tool types over several millennia appears in contrast to the regional variation apparent in the Early and Middle Mesolithic forms. This decrease in regional variation may indicate that LLS forms became a standardised item that was utilised in more creative composite arrangements.

The chronology of Final Mesolithic forms is dominated by measurements associated with rod microliths; we have included a single result associated with microtranchets in the analysis which indicates these forms' presence in the second half of the 5th millennium cal BC, however this cannot be representative, and indeed initial work from Bexhill indicates these forms have a wider currency (Donnelly *et al.* 2019). Estimates for the chronology of Final forms are relatively imprecise, in part because we have few measurements associated with lithic technologies from this period. We estimate the use of Final Mesolithic forms began in the 49th–46th centuries cal BC (71% probability). Rod microliths appear to have first been used in the 43rd or 42nd centuries cal BC (85% probability), with Final Mesolithic forms going out of use in the 39th–37th centuries cal BC (74% probability).

DISCUSSION

Typo-chronology and temporal narratives

Our analyses reveal the need to unite two fundamental Mesolithic datasets, stone tools and organic remains; historically in Mesolithic studies, approaches to these

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TABLE 2. HIGHEST POSTERIOR DENSITY INTERVALS FOR KEY PARAMETERS FROM DIAGNOSTIC LITHIC INDUSTRIES AND ASSEMBLAGE TYPES CALCULATED AS SHOWN IN FIGURE 7

Assemblage or industry type	*Highest posterior density interval (95% probable)*	*Highest posterior density interval (68% probable)*	*Parameter name in* Fig. 7
Early Mesolithic assemblage types	**9425–9255**	**9350–9275**	**start_early_mesolithic_forms**
Star Carr	9350–9245	9315–9265	first_Star_Carr
Deepcar	9155–8520	8830–8570 (60%)	first_Deepcar
Cramond	8585–8300	8465–8325	start_Cramond_site
Nab Head	8625–8310	8555–8375	first_Nab_Head
Middle Mesolithic assemblage types	**8550–8145**	**8380–8245**	**start_middle_mesolithic_forms**
Honey Hill	8290–8015	8235–8085	first_Honey_Hill_forms
VSL	8570–8195 (90%)	8290–8230	first_variably_lateralised_scalenes_forms
Horsham	8290–7815	8250–7990	first_Horsham_forms
Late Mesolithic forms	**7410–6865**	**7200–6950**	**start_late_mesolithic_forms**
LLS	7185–6840	7080–6910	first_left_lateralised_scalenes
Final Mesolithic forms	**5265–4385**	**4920–4540**	**start_final_mesolithic_forms**
Microtranchets	4900–4445	4770–4535 (62%)	BM-2404
Rods	4350–4090	4260–4140	first_rods

datasets have been co-opted to produce narratives operating at very different temporal and spatial scales.

We advocate working between a typo-chronological scheme and chronometric data – as in the method developed here – to critically examine evidence for change, to integrate these different scales of enquiry and counter culture historic legacies in Mesolithic studies, so that we can produce new, nuanced, and synthetic narratives. There are processes and practices that cut across the use of these forms of material culture, underlining the *eventfulness* that characterised past worlds. This typo-chronological scheme provides a temporal framework, a heuristic to make more relevant comparisons across different regions and provide better stories of people and the lives they lived during this period.

Early Mesolithic: 94th/93rd–83rd/80th centuries cal BC: Early Mesolithic assemblages include Star Carr, Deepcar, Nab Head, and Cramond types of microlith (Figs 1, 7, & 8). Nab Head and Cramond types are regionally localised (to southern Wales and eastern Scotland respectively). Star Carr types are mainly confined to northern Britain but are occasionally present in the south, while Deepcar types span England and Wales. People moved into Britain in the early Holocene along the coast in the north and major rivers in the south. Groups using Star Carr type microliths seem to represent pioneer settlement in northern Britain; the situation in the south is more ambiguous. Following initial occupation, certain locations quickly gained meaning and significance, with Star Carr revisited over a period of 800 years (Milner *et al.* 2018). For people using Star Carr microliths in the north, wetlands, coasts, and rivers were preferred but there are also sites in the uplands and logistical settlement strategies were favoured. In the south, low gravel islands by major rivers were favoured places (Conneller 2021). Settlement in the south seems relatively sparse before *c.* 8700 cal BC, thereafter groups with Deepcar type microliths expanded into new areas beyond river valleys. Deepcar settlements are found in a wider range of geographical locations, tend to be relatively large, and show relatively little differentiation in terms of proportions of major tool types, probably reflecting a shift from a collector to a forager strategy (Reynier 2005). The later dates and localised distribution of

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Cramond and Nab Head microliths suggest regionalisation, a process that subsequently becomes more pronounced.

Middle Mesolithic: 84th/83rd–70th/69th centuries cal BC*:* This period is defined by Horsham, Honey Hill, and Variably Lateralised Scalene (VLS) assemblages (Figs 2, 7, & 8). It sees continued infilling of the landscape, but also distinctively new ways of living. Areas where earlier post-glacial settlement was sparse (eg, Scotland) or absent (parts of the English midlands) have radiocarbon dated sites for the first time. Strong regional trajectories also emerge, with VLS using groups in the north, Honey Hill microliths in the English midlands, and Horsham in southern England. New modes of engagement with the landscape occurred: In the north, large, circular houses were built (Waddington 2015); pits focused on hazelnut processing and the deposition of burnt materials, probably hearth sweepings, are increasingly common. Such features are less common in the south, but hearths, pits, and hazelnuts are all present (Conneller 2021). Other practices are regionally specific: Numerous extremely large pits are present in north-east Scotland (Gaffney *et al.* 2013, Dingwall *et al.* 2019), and southern England (Allen & Gardiner 2002); isolated human remains are found in caves in South Wales and south-west England (Conneller 2006).

Late Mesolithic: 72nd/70th–47th/45th centuries cal BC: This period, defined by Left Lateralised Scalene (LLS) assemblages (Figs 3, 7, & 8), is regionally varied: in many areas there is continuity in settlement foci; a concern with past activities can be seen, with some pits being recut and other features re-used. Middening seems an important practice: middens of lithics and animal bone are found on inland sites and of shell and animal bone in coastal areas of northern Britain and forested near-coastal regions of the south-west (Conneller 2021). Pits, scoops, and tree-throws were often used for middening, but there is less focus on the disposal of burnt material than previously. Regional diversity is a key feature of the evidence. In south-west Britain, people evinced an interest in colourful pools and springs (Davis 2012); elsewhere they were drawn to colourful, lustrous materials such as Rhum bloodstone, Arran pitchstone, and Portland chert (Care 1982; Ballin 2009; 2018). There is also diversity in the treatment of human remains: deposition of isolated human remains in caves continues in southern Wales (Conneller 2006) with both burial and cremation in eastern England (Schulting 2013; Gilmour & Lowe 2015).

Final Mesolithic: 49th/46th–39th/36th centuries cal BC: The distinction between Late and Final Mesolithic assemblages is less well resolved, due to continuity of microlith forms in some areas, and a paucity of well-dated sites in others. The Bexhill publication (in prep.) will help refine this. In parts of Britain, though not others, new microlith types appear in the 5th millennium (Figs 4, 7, & 8). Symmetric and asymmetric microtranchets are found from Sussex to Cumbria and might be interpreted as insular renderings of continental trapezes and transverse arrowheads. Though there is considerable continuity with the preceding period in terms of settlement focus, it was also a time of change, with evidence for different practices in different regions. Monumental scale middens are present, mostly on the east coast of Scotland, but also on the island of Oronsay (Mellars 1987). There was increased intensity in the occupation of the Pennines, where fixed features including ovens and hearths were built in areas cleared by fire. Shifts in raw material use in this region during the 5th millennium culminate in changes of forms accompanied by use of exotic, high quality lithic material. New forms of material culture reference areas beyond Britain: T-axes, the Ertebølle type-fossils, are found in Scotland (Elliott 2015), and polished axes in Cumbria may show connections with Ireland (Brown *et al.* 2024).

Typologies and chronologies: using different datasets

This project has generated two different datasets which can be used to plot the geographical distribution of Mesolithic activity. These are, first, the distribution of radiocarbon measurements between *c.* 9800 and 3600 cal BC. These can inform us about the history of archaeological research for these time periods, as well as potentially providing clues to past human activity, though as proxies for human populations this is perhaps less useful. Our second dataset is typologically diagnostic sites. Most are undated, so this dataset allows us to expand our

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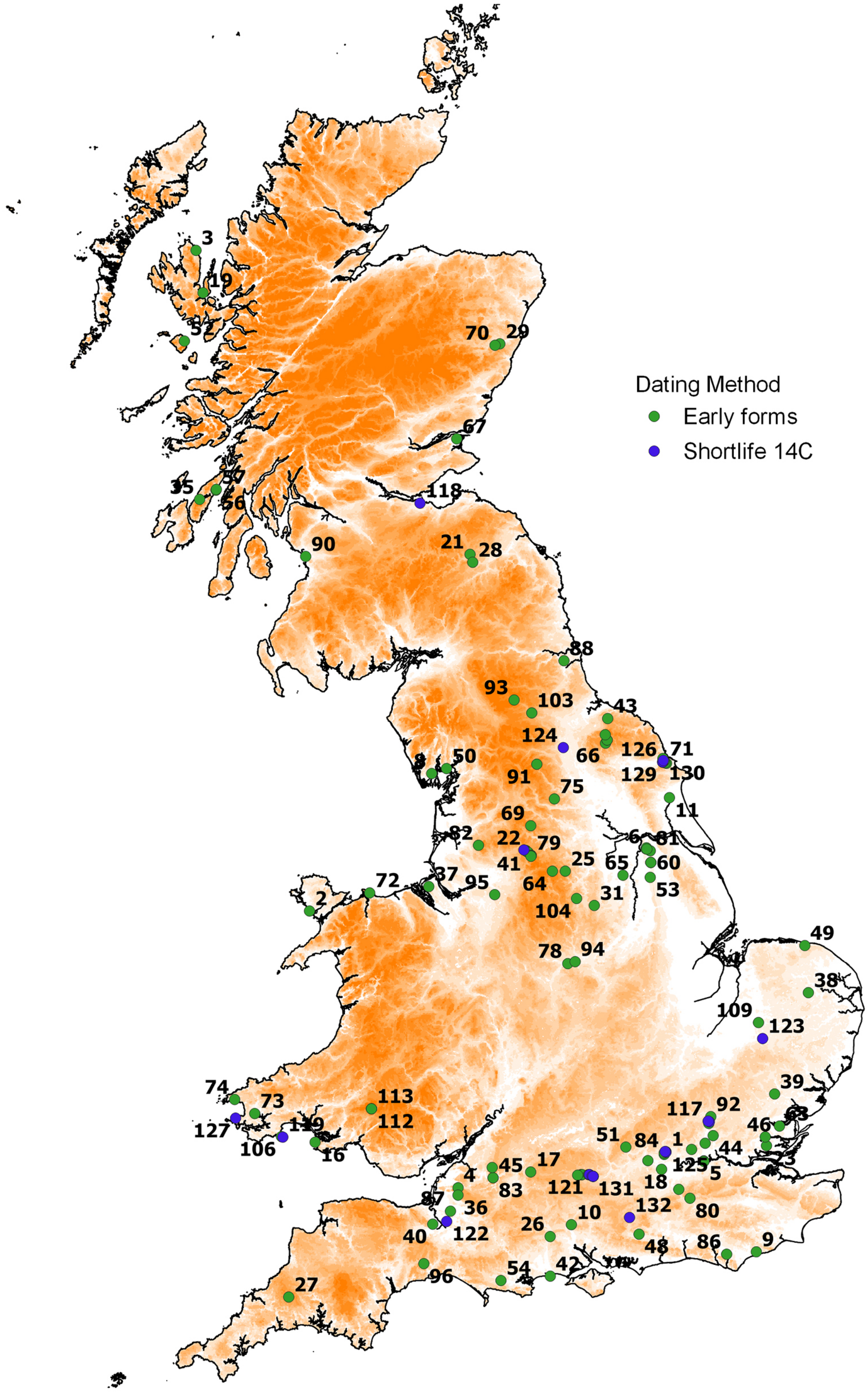

Fig. 9.
Sites with typologically Early Mesolithic forms *c*. 9400–8200 cal BC. 1. 100 Acre Pit; 2. Aberffraw; 3. An Corran; 4. Aveline's Hole; 5. B&Q site; 6. Bagmoor; 7. Barry's Island; 8. Bart's Shelter; 9. Bexhill; 10. Bossington; 11. Brigham Hill;

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distribution plots to include additional sites. Identifying trends over time in these data can provide allied evidence for changes in past practices.

Early microlith forms have been recognised across Britain, resulting in a more representative geographic distribution (Fig. 9). Middle Mesolithic forms (Fig. 10) are extremely distinctive in certain regions but have only recently been recognised in south-west England (Norman 2001) and are poorly understood in south Wales, resulting in some geographic patchiness to the typological distribution map.

We do not include maps of Late and Final forms for the following reasons: distinctive Final Mesolithic forms are not always present on the latest Mesolithic sites (as they are often relatively rare components amongst types with a longer currency) and they have thus far not been recognised in Scotland. Late Mesolithic forms are more problematic to plot on a typological basis, as these assemblages are less typologically distinctive, lacking a distinctive 'type-fossil'; LLS triangles are also present in Middle and Final Mesolithic assemblages, meaning that, while larger sites can be easily categorised, smaller and mixed scatters are more ambiguous.

Early forms: Figures 9 and 11 show that Early forms are found in many more locations than short-life samples. Overall, radiocarbon measurements provide a very poor representation of patterns of landscape inhabitation as datable materials are sparse; pits and built hearths do not feature in the record, and pre-hazel rise datable material is rare. However, the typological map lacks some key sites where microliths are *not* present. For example, cave burials from this period are rarely associated with microliths, yet these rites represent an important facet of Mesolithic lives. Similarly, stray finds of barbed points from the Thames have been radiocarbon dated to this period but are not associated with diagnostic microliths. Figure 11a–b, by contrast, though patchier geographically, provides a more nuanced understanding of temporal processes of inhabitation; a sparsity of data until the *c.* 85th century, followed by an increase in the numbers of sites with short-life terrestrial radiocarbon measurements.

Middle forms: The picture for Middle forms is more mixed. A greater density of sites is visible in south-east England and parts of the English midlands on the typological map (Fig. 10) in comparison to the short-life samples (Fig. 11c–d). However, the short-life sample map shows a much clearer Middle Mesolithic presence in Wales and south-west England. This is partly because the Middle Mesolithic forms do not seem to be distinctive in south Wales and have only more recently been recognised in south-west England (Norman 2001) and here the short-life map shows

12. Broxbourne 102; 13. Wawcott XV; 14. Wawcott XXX; 15. Broxbourne 106E; 16. Burry Holms; 17. Cherhill; 18. Church Lammas; 19. Clachan Harbour; 20. Cowley Mill; 21. Craigsford Mains; 22. Waystone Edge 1; 23. Daws Heath; 24. West Heath; 25. Deepcar; 26. Downton (patinated); 27. Dozmary Pool; 28. Dryburgh Mains; 29. East Park; 30. Eton Rowing Course; 31. Whaley Rock Shelter; 32. Fetcham; 33. Flixton 1; 34. Flixton School; 35. Glenbatrick Water Hole; 36. Gough's Cave; 37. Greasby; 38. Great Melton; 39. White Colne; 40. Greenway Farm; 41. White Hassocks 1/2; 42. Hengistbury Head; 43. Highcliff Nab; 44. Hillwood; 45. Hot Spring; 46. Hullbridge; 47. Ikea site; 48. Iping Common; 49. Kelling Heath; 50. Kent's Bank Cavern; 51. Kimble Farm; 52. Kinloch; 53. Willoughton A; 54. Winfrith Heath; 55. Lominot 2/3/C; 56. Lussa Bay; 57. Lussa Wood; 58. Manton Warren 1; 59. Manton Warren V; 60. Manton Warren Pond; 61. Marlborough Grove; 62. Marsh Benham; 63. Maylandsea; 64. Mickleden 1–4; 65. Misterton Carr I; 66. Money Howe I; 67. Morton A; 68. Roxby Sands; 69. Nab Water; 70. Nethermills; 71. No Name Hill; 72. Ogof Pant-y-Wennol; 73. Palmerston Farm; 74. Penpant; 75. Pike Lowe 1; 76. Pointed Stone 2; 77. Pointed Stone 3; 78. Potlock; 79. Pule Hill Base; 80. Reigate Heath; 81. Risby Warren; 82. Rushy Brow; 83. Sacred Spring; 84. Sandstone; 85. Seamer L; 86. Selmeston; 87. Shapwick; 88. Sheddon's Hill; 89. Sheffields Hill; 90. Shewalton Moor; 91. South Haw; 92. Stanstead Abbots 2; 93. Staple Crag; 94. Swarkstone Lowes; 95. Tatton Mere; 96. Telegraph Cottage; 97. Thatcham I; 98. Thatcham II; 99. Thatcham III patinated; 100. Thatcham IV; 101. Thatcham V; 102. Tog Hill; 103. Towler Hill; 104. Unstone I; 105. Urra Moor; 106. Valley Field; 107. Victoria Park; 108. VPD; 109. Wangford/Lakenheath Warren; 110. Warcock Hill North; 111. Warcock Hill South/Turnpike; 112. Waun Fignen Felen 2; 113. Waun Fignen Felen 6; 114. Waun Fignen Felen 8; 115. Wawcott IV; 116. Broxbourne 104; 117. Broxbourne 106; 118. Cramond; 119. Daylight Rock; 120. Faraday Road; 121. Greenham Dairy Farm; 122. Greylake, Middlezoy; 123. Lackford Heath; 124. Little Holtby; 125. Sanderson; 126. Star Carr; 127. Nab Head I; 128. Three Ways Wharf; 129. Seamer C; 130. Seamer K; 131. Newbury Sewage Works; 132. Oakhanger V/VII; 133. Windy Hill 3; 134. Thatcham III

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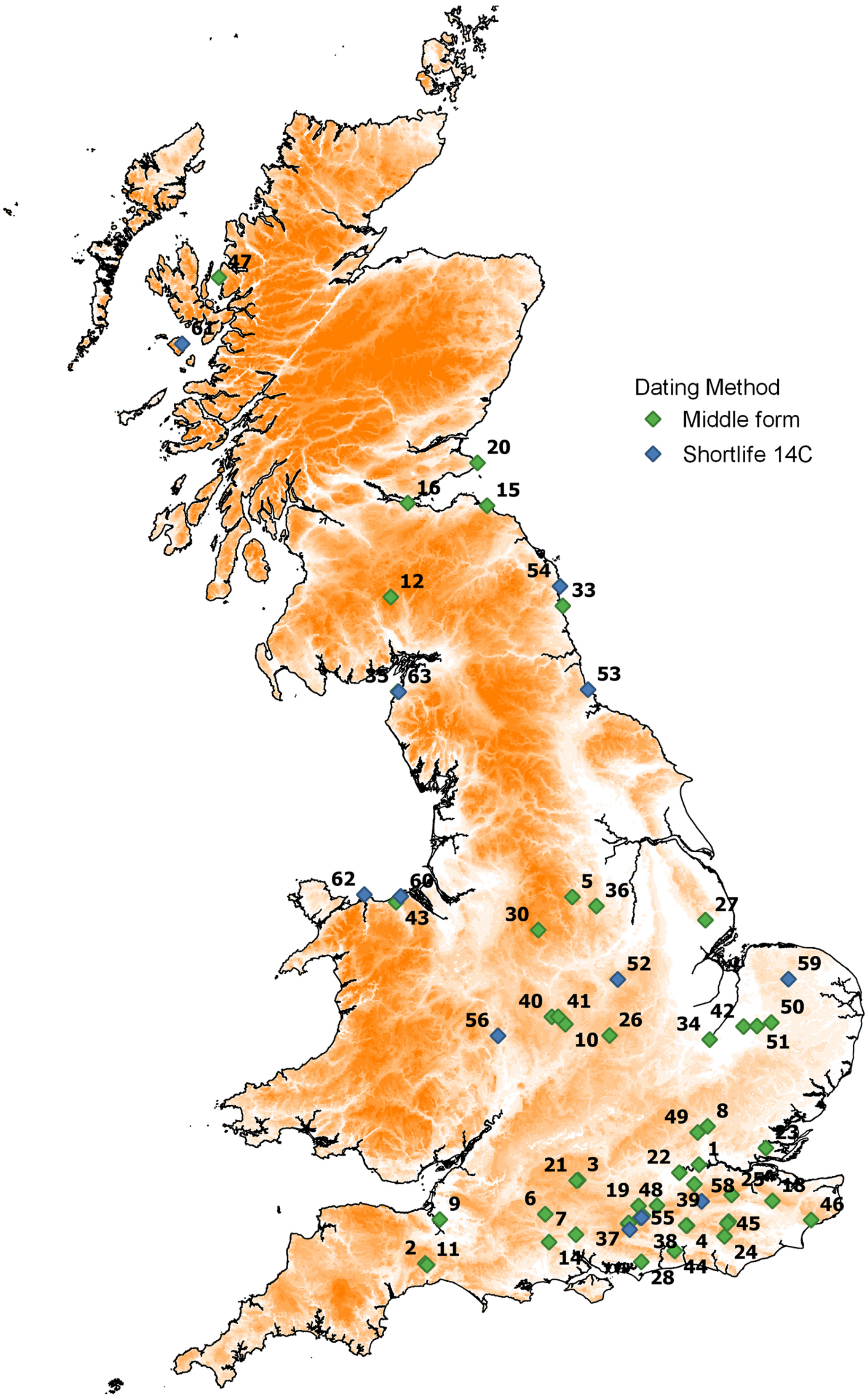

Fig. 10.
Sites with typologically Middle Mesolithic forms *c*. 8500–6900 cal BC. 1. Addington St; 2. Aller Farm; 3. Wawcott III; 4. Beeding Wood; 5. Blake Acre Bradwell; 6. Blick Mead; 7. Broom Hill; 8. Broxbourne 106; 9. Partchy Sand Patch;

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cave burials which lack contemporary microliths (Conneller 2006). In Scotland and northern England, the datasets show similar patterns, because sites are both typologically distinctive and contain quantities of datable burnt hazelnuts. This comparison demonstrates that in periods when microliths are typologically distinctive, a fuller picture of occupation is obtained; but when microliths are not distinctive, plotting radiocarbon samples may be more useful to understand geographical breadth of human presence in the landscape. Above all, the two approaches need to be used in tandem.

While we have not presented typological maps to compare with short-life radiocarbon plots for *c.* 7200–3600 cal BC (Fig. 11d–h), there appear no major shifts in the number or distribution of radiocarbon dates over this period. There is a gradual decrease in numbers of sites over the 7th millennium, which may relate to a shift in middening practices, from preferential deposition of hearth sweepings to a more varied range of materials. As noted above, distinctive Final Mesolithic microliths are patchily distributed. Generally, the distribution of distinctive Final forms in England and Wales (Conneller 2021, fig. 5.1) broadly echoes the short-life material (though showing greater intensity in the Pennines and North York Moors); there is a paucity of Late and Final form sites in the English midlands. Otherwise, Final Mesolithic occupation appears at similar levels to earlier periods, before declining from the 41st century (Fig. 11h).

It is important to recognise that these two datasets – and the intellectual work underpinning them – are produced as *practices* of knowledge creation (cf. Lucas 2019). Comparing these datasets demonstrates some of the issues with the use of radiocarbon measurements in a 'dates as data' approach; they are subject to people in the past engaging in practices that produced suitable radiocarbon samples, the deposition and preservation of these samples in appropriate conditions, recognition, and sampling of these deposits through archaeological excavation, and, critically, the ability of researchers – situated in our discipline's intellectual history – to identify these evidence sets as important and worthy of scientific investigation. While typological approaches can be used to better understand the extent and perhaps nature of Mesolithic occupation, they necessarily compress evidence for complexity and change by flattening the temporal aspect of lived existence; they thus 'risk abstracting time, reifying change into binary flips between binary lifeways' (Griffiths 2017, see also Crellin 2020). It is therefore extremely important to work between these different analytical approaches, and to think about the production of archaeological evidence in terms of *events*, which are situated in time and space, simultaneously created in the past and in our contemporary understandings.

CONCLUSIONS: TIME, CULTURE, AND STONE TOOLS

This paper has explored impressions of Mesolithic life produced variously from stone tools and organics and the part that these evidence types play in generating particular forms of temporality and narrative. We have argued that chronological information and material culture need to be used as allied datasets, indeed there are particular strengths, which draw on the history of our discipline, when they are combined to produce a typo-chronological scheme for stone tools in the 10th–4th millennia cal BC. Each dataset has different strengths, with distinctive typologies useful for providing a better geographical coverage, and radiocarbon measurements used in this way providing alternative understandings of processes. Moving between these datasets we can understand patterns and forms of Mesolithic landscape inhabitation and social change, though this period remains one which urgently needs more and better chronological data to create nuanced narratives of complex times.

The production of a revised typo-chronological scheme offers many advantages, including: better

10. Corley Rocks; 11. Crandon's Cross; 12. Daer Reservoir I; 13. Devil's Jump Moor; 14. Downton; 15. East Barns; 16. Echline; 17. Eridge; 18. Fairbourne Court; 19. Farnham; 20. Fife Ness; 21. Wawcott IV; 22. Ham Fields; 23. Hamborough Hill; 24. Hermitage; 25. High Rocks; 26. Honey Hill; 27. West Keal; 28. Westhampnett; 29. Kettlebury I&II; 30. Wetton Mill; 31. Lion's Mouth; 32. Oakhanger I; 33. Low Hauxley; 34. Marlow Ridges Over; 35. Maryport (Netherhall Rd); 36. Mother Grundy's Parlour; 37. Oakhanger VII; 38. Old Faygate; 39. Orchard Hill; 40. Over Whiteacre Spring; 41. Over Whiteacre 4; 42. Peacock's Farm; 43. Rhuddlan E/M; 44. Rock Common; 45. Rocks Wood; 46. Saltwood Tunnel; 47. Sand; 48. St Catherine's Hill; 49. Thorntons Farm; 50. Two Mile Bottom; 51. Wangford; 52. Asfordby; 53. Filpoke Beacon; 54. Howick; 55. Kettlebury 103; 56. Lightmarsh Farm; 57. Longmoor I; 58. North Park Farm; 59. Spong Hill; 60. Prestatyn; 61. Kinloch; 62. Snail Cave; 63. Netherhall

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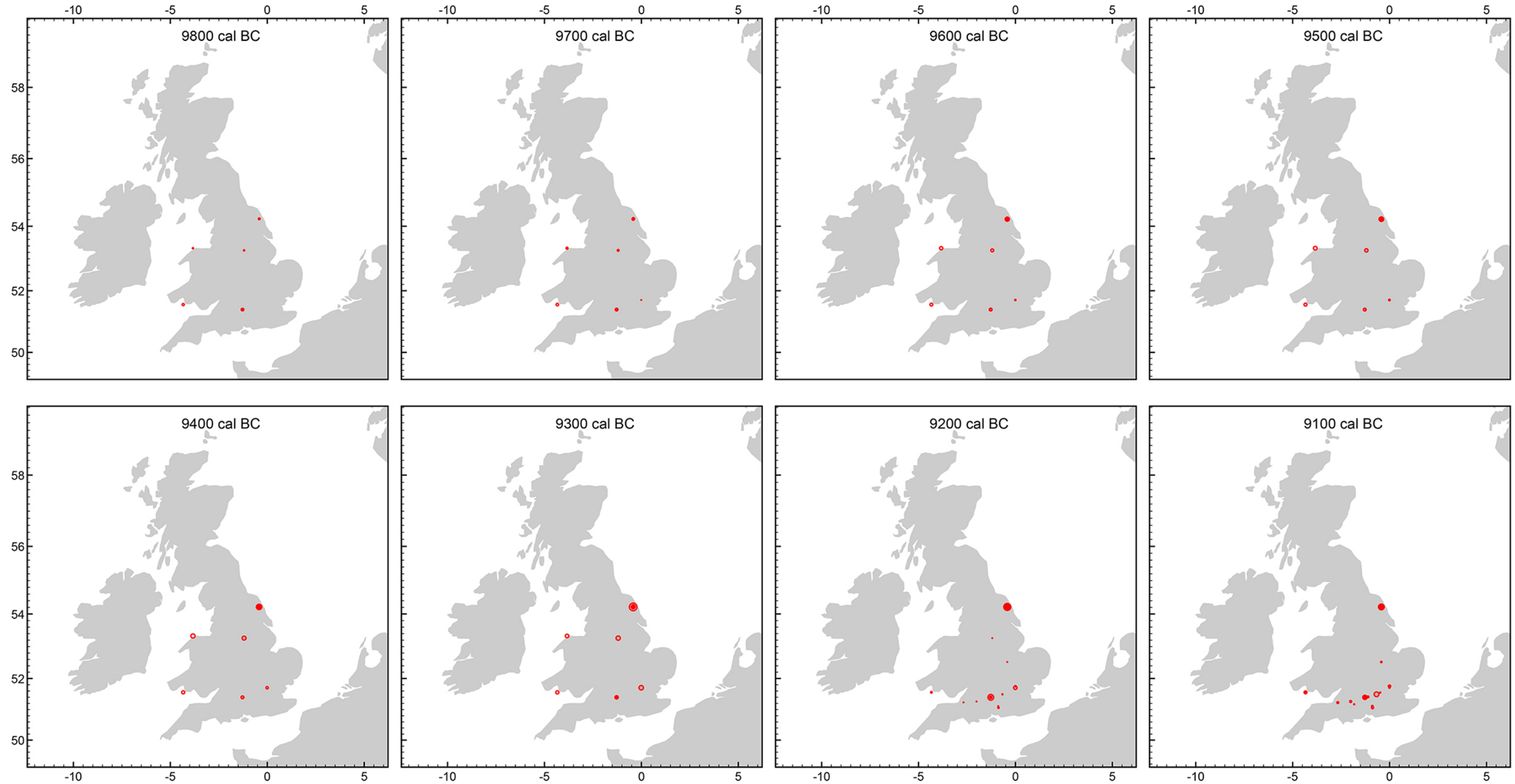

Fig. 11a.
Time slices, 9800–9100 cal BC. Posterior density estimates on all short-life samples from the period

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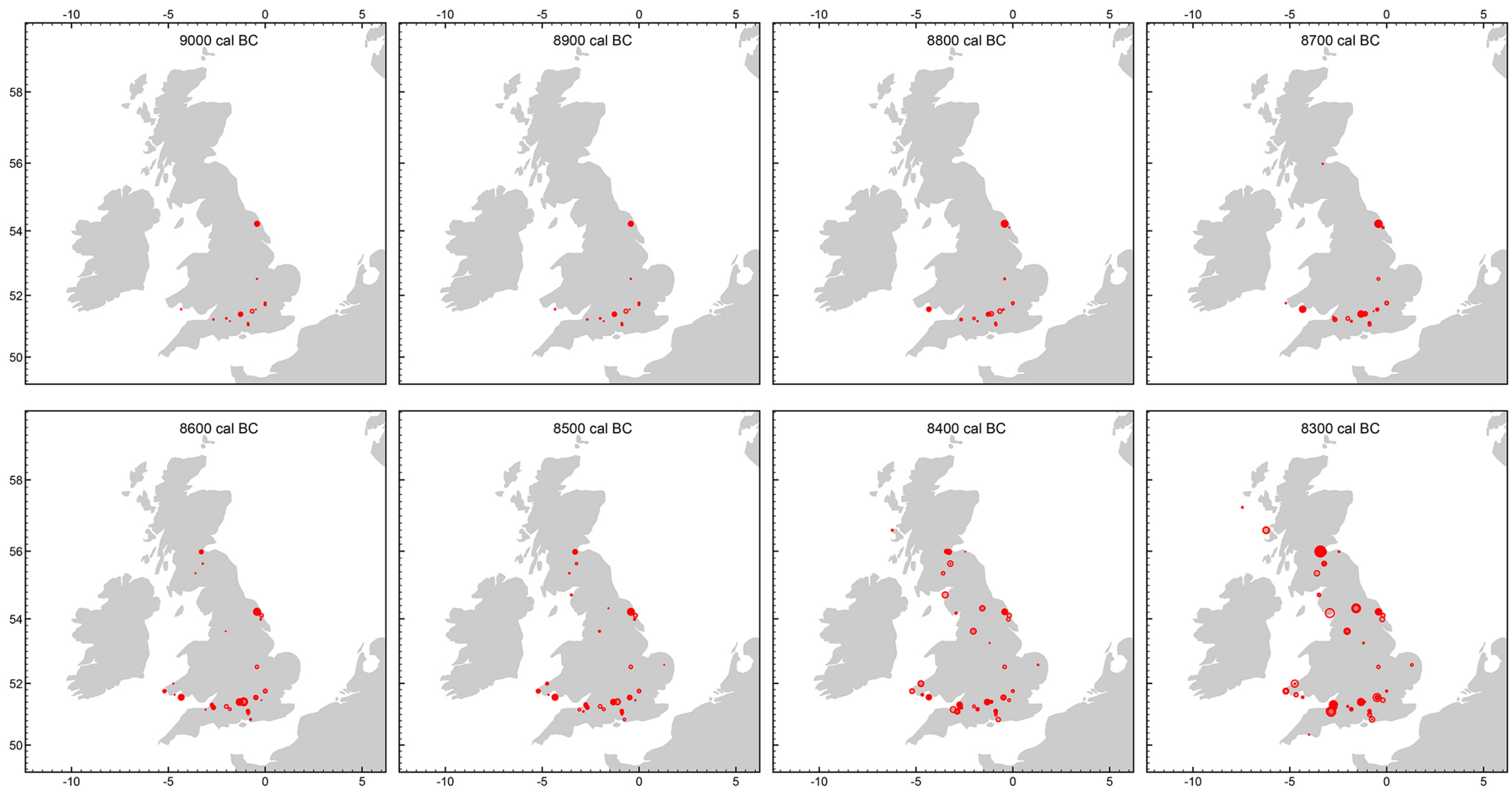

Fig. 11b.
Time-slices, 9000-8300 cal BC. Posterior density estimates on all short-life samples from the period

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Fig. 11c.
Time-slices, 8200–7500 cal BC. Posterior density estimates on all short-life samples from the period

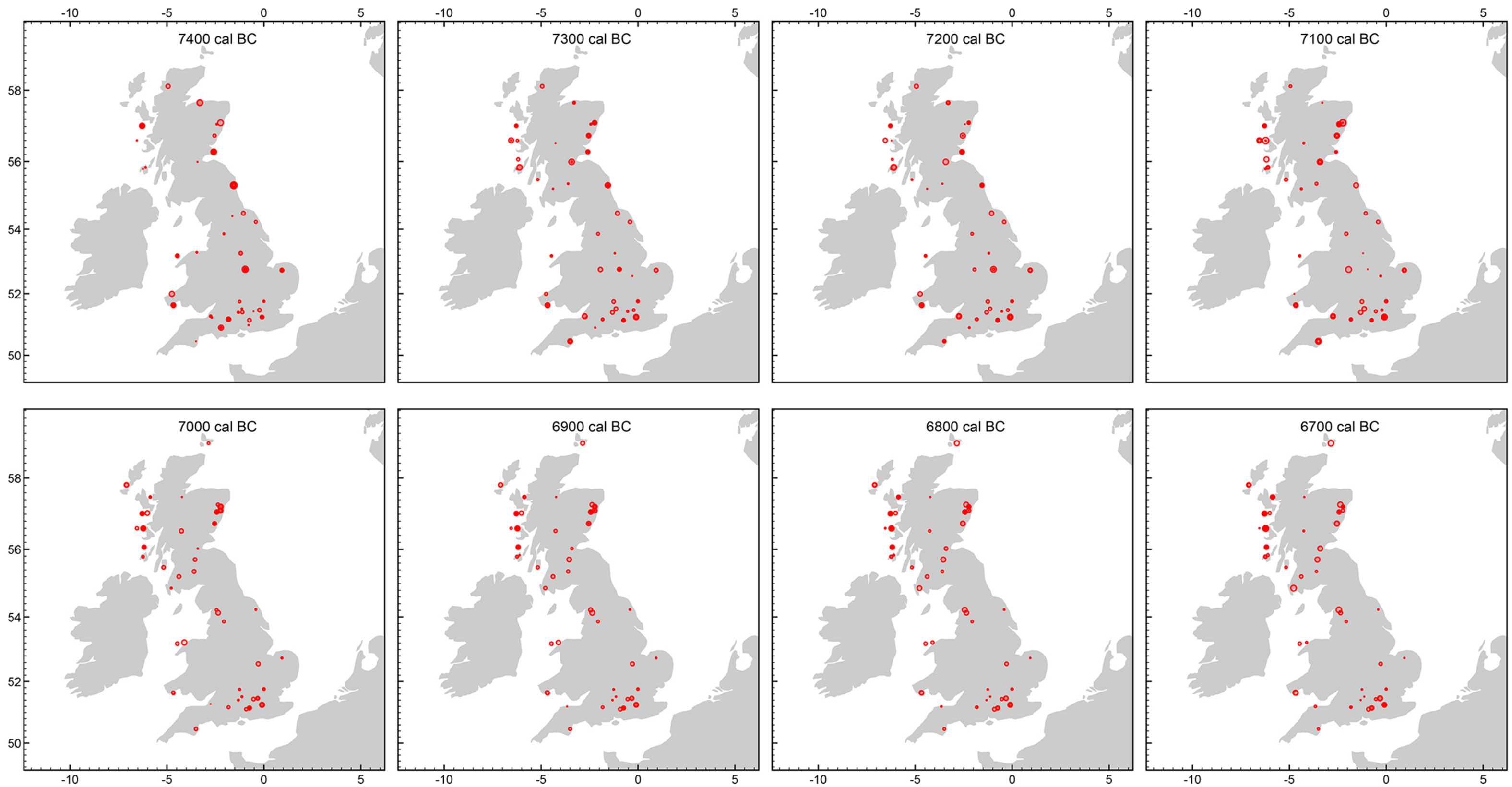

Fig. 11d.
Time-slices, 7400–6700 cal BC. Posterior density estimates on all short-life samples from the period

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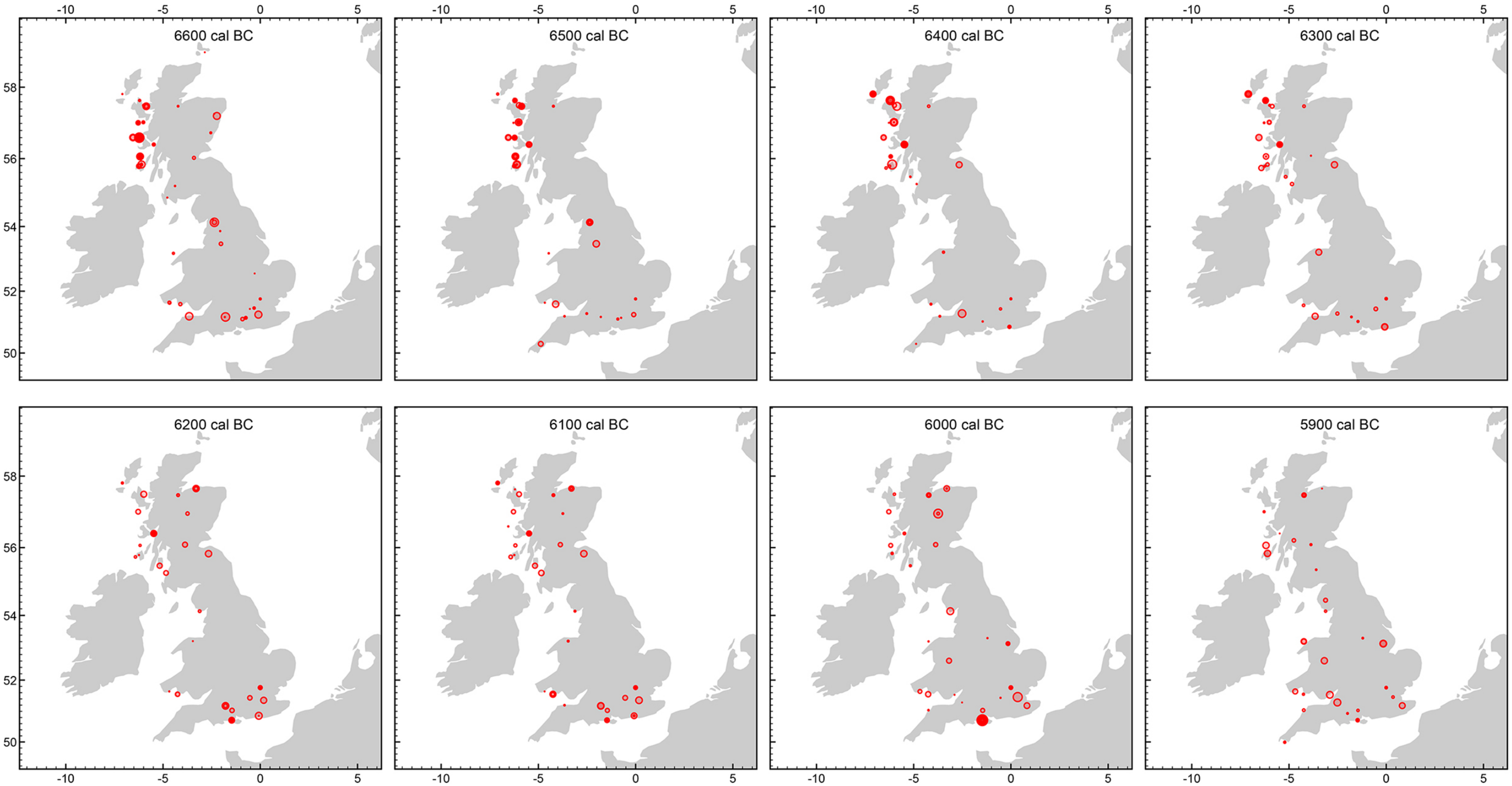

Fig. 11e.
Time-slices, 6600–5900 cal BC. Posterior density estimates on all short-life samples from the period

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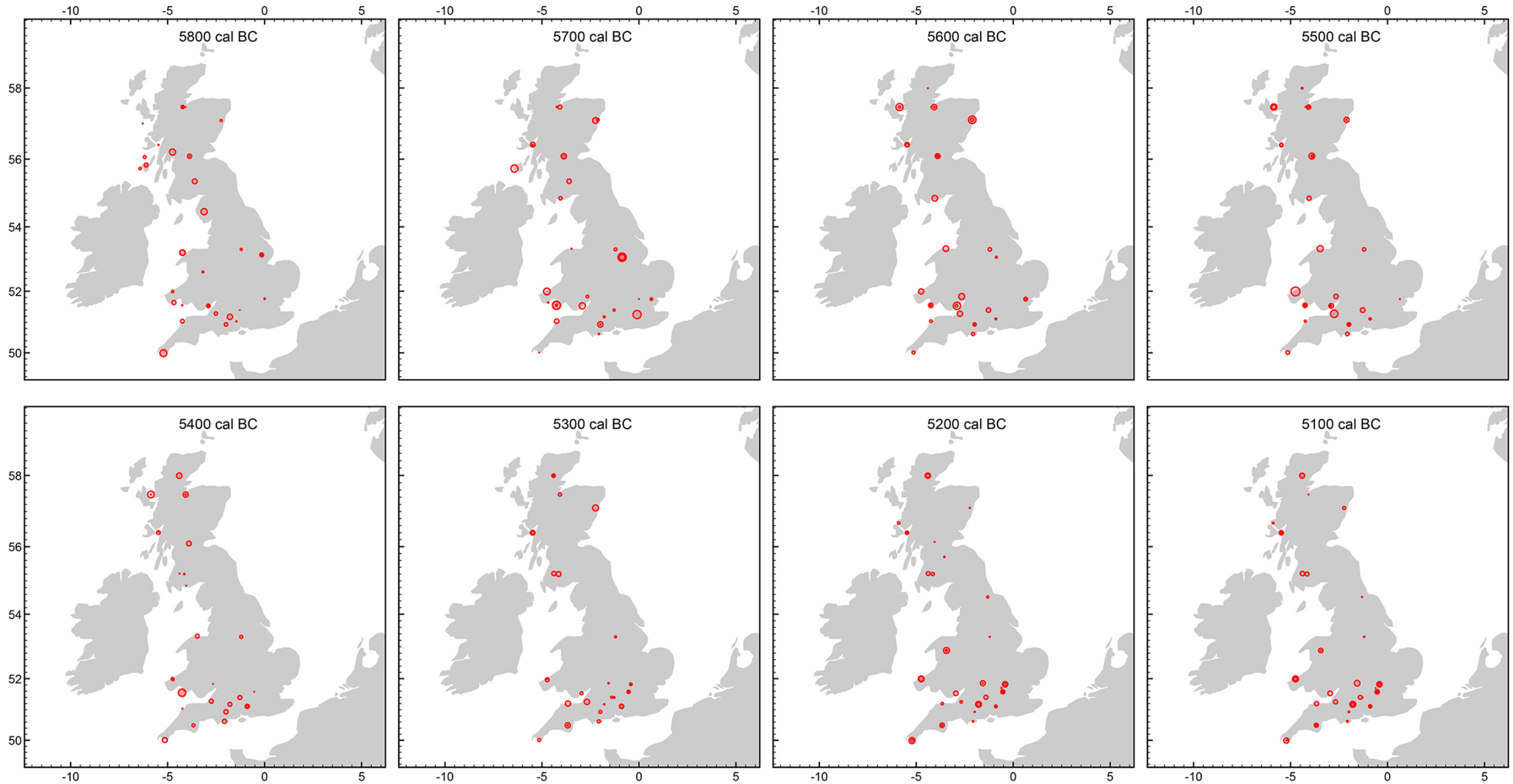

Fig. 11f.
Time-slices, 5800–5100 cal BC. Posterior density estimates on all short-life samples from the period

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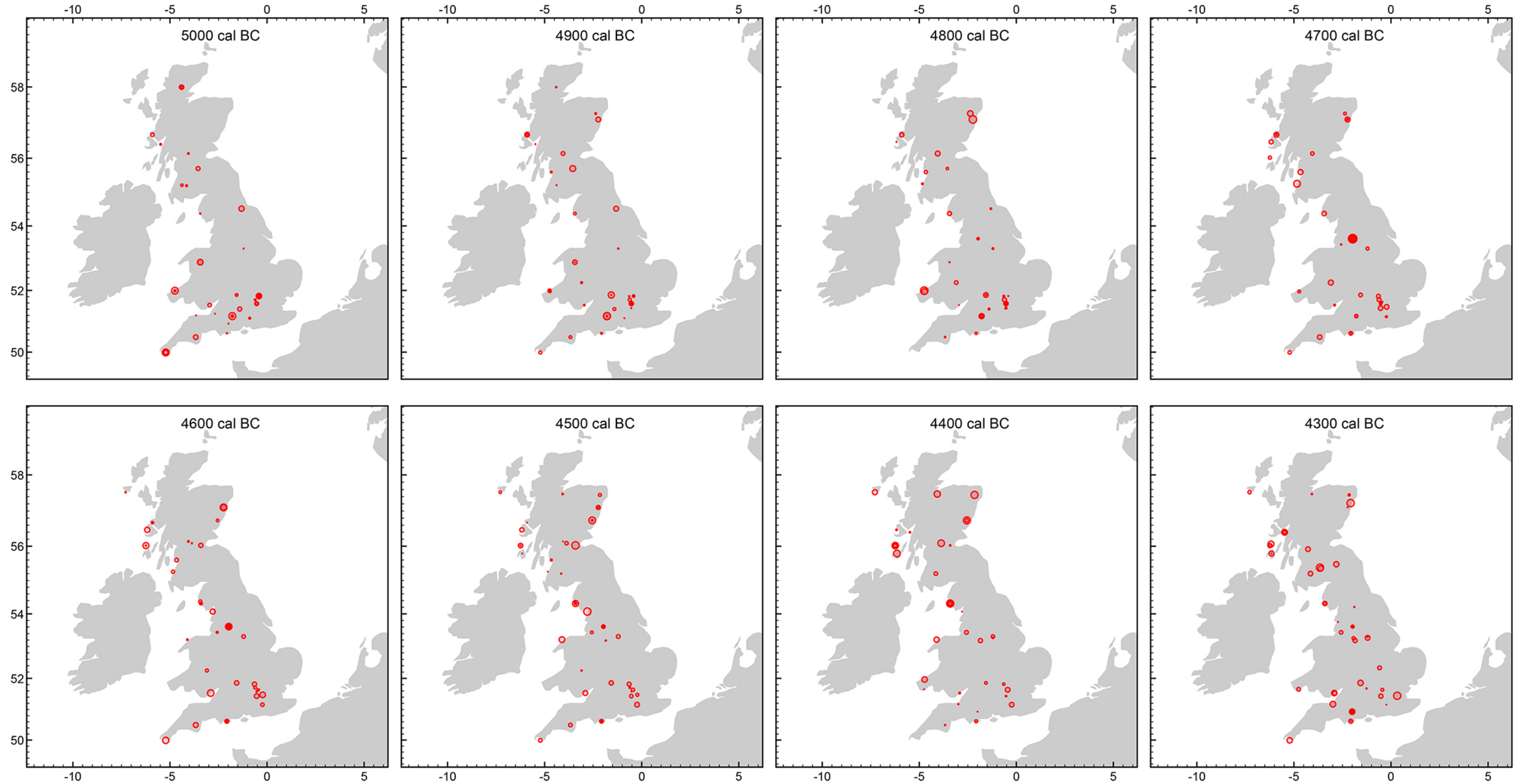

Fig. 11g.
Time-slices, 5000–4300 cal BC. Posterior density estimates on all short-life samples from the period

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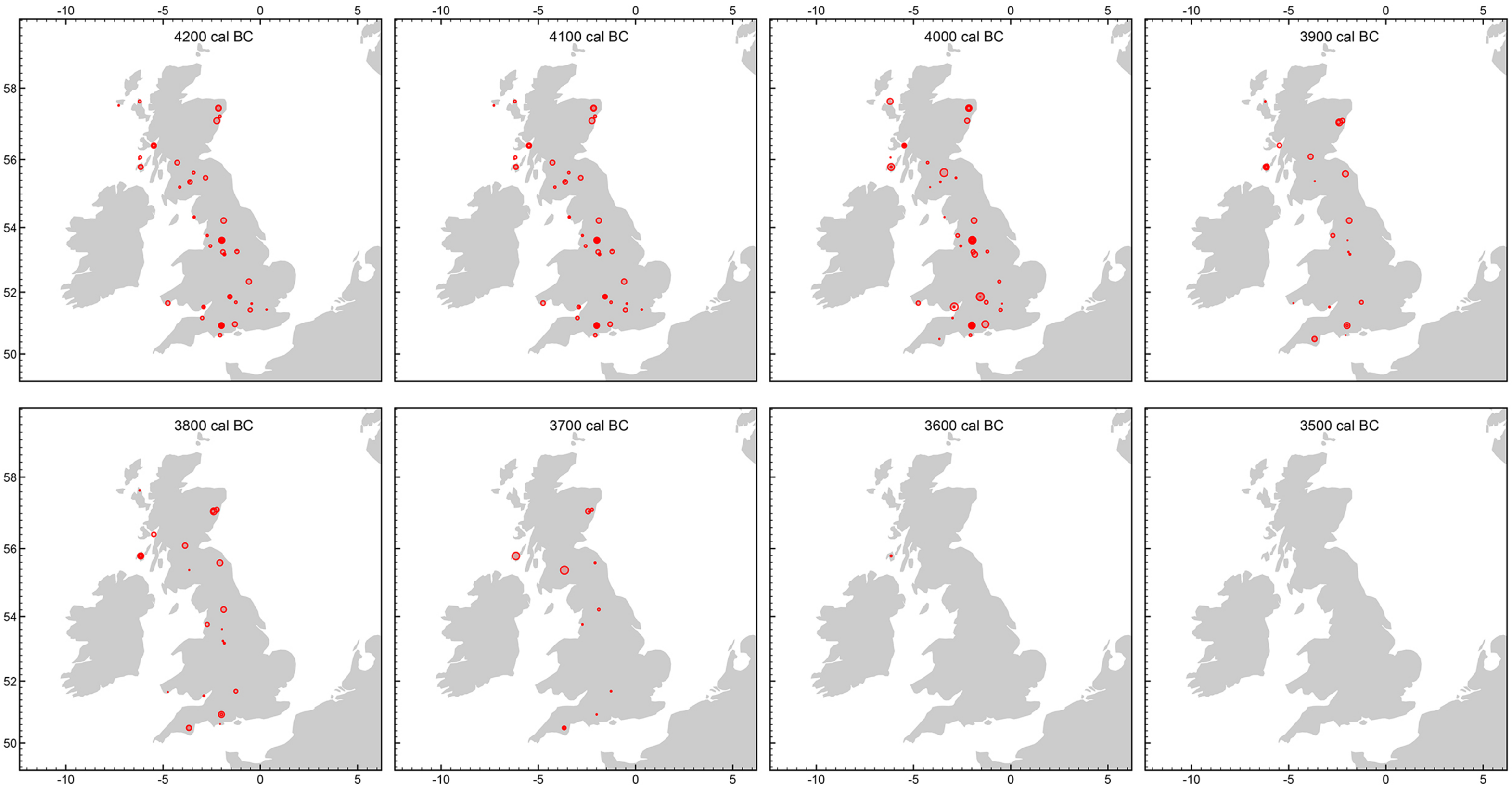

Fig. 11h.
Time-slices, 4200–3500 cal BC. Posterior density estimates on all short-life samples from the period

understandings of sites lacking organic materials; the potential for chronological narratives in regions where datable materials are rare; and more relevant comparisons across Britain. Perhaps most important is reclaiming the period when people used microliths as one of change, a period of lived lives and uncertain futures, rather than a time of stasis and endlessly repeating seasonal rounds, the prelude to the dynamic, rapidly changing times of agriculturalists. The latter has had the unfortunate effect of perpetuating old, troubling narratives of hunter-gatherers as 'people without history'. In contrast, our approach has identified new evidence for highly variable practices over 6000 years with clear evidence for temporal change; the 5th millennium specifically appears particularly dynamic, a contrast with previous narratives of population decline.

Our approach challenges the culture history legacy that has persisted in Mesolithic studies, which perpetuated a view of lifeways as homogeneous, with change immediate, and with 'the Mesolithic' taking on an unwarranted and spurious cultural and intellectual validity. This impression is taken from relying on a series of exceptionally atypical sites and is no longer warranted.

Lucas and Vesteinsson (2024) argue that we need to distinguish between the dating and narrative functions of periodisation and that while advances in radiocarbon dating may allow us to bypass the former, the latter is likely to remain. The future aim for 'Mesolithic studies' must be to strip from this narrative element tendencies to create a past understood in terms of homogeneity and synchronicity. As a heuristic purely based on a single element, microlith form, the typo-chronological scheme presented here should not carry any implication of synchronicity, which would simply replace the old bipartite scheme with a fourfold division. Changes in material culture forms need to be understood within the complex nature of every human society, drawing on a variety of strands of evidence. Interpreting our patterns in terms of lived experiences requires us to move beyond simplistic explanations that invoke population, culture, or environment as monocausal catalysts for change. Instead, the aim of this new scheme is as a framework for making more relevant comparisons between regions and to create a broad sense of change over time. This we argue is the basis from which we can produce better, more temporal narratives for these people and the worlds in which they lived.

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SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/ppr.2024.14

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RÉSUMÉ

Temps et changement dans la Grande-Bretagne Mésolithique 9800–3600 cal BC, par Chantal Conneller et Seren Griffiths

Le Mésolithique a été caractérisé comme temporellement homogène : une période de stagnation ou même de dégénérescence avec des chasseurs-collecteurs concentrés sur les pratiques économiques quotidiennes dans un cycle saisonnier se répétant sans fin. Cette caractérisation du Mésolithique comme intemporel et immuable provient en partie de la faiblesse de notre résolution chronologique interne, laquelle apparait encore plus grande en comparaison avec les récentes avancées majeures, en termes de précision chronologique, pour les périodes adjacentes. Toutefois, ces tendances sont exacerbées par l'attention particulière des recherches sur le Mésolithique au cadre typologique bipartite obsolète et simplifié pour la période, cadre lié à un petit nombre de sites bien préservés et qui est venu à représenter les modes de vies humaines pour des millénaires. Nous avançons qu'il nous faut à la fois des chronologies plus justes et précises, et des approches narratives qui écrivent l'histoire de ces peuples dans leur propres temps émergents et incertains. Afin d'entamer cette tâche, cet article présente un nouveau cadre chronologique pour les assemblages Mésolithiques britanniques, établi à partir de la collecte, vérification, et modélisation bayésienne de mesures radiocarbones associées à des formes microlithiques. Nous soulignons également les différentes compréhensions de temporalité et d'habitat pour la période *c.* 9500–3500 cal BC.

ZUSAMMENFASSUNG

Zeit und Wandel im mesolithischen Großbritannien 9800–3600 cal BC, von Chantal Conneller und Seren Griffiths

Das Mesolithikum wurde als zeitlich homogen charakterisiert: eine Periode der Stagnation oder sogar Degeneration mit Jägern und Sammlern, die sich auf wirtschaftliche Routinepraktiken in einem sich endlos wiederholenden saisonalen Zyklus konzentrierten. Die Charakterisierung des Mesolithikums als zeitlos und unveränderlich ist zum Teil auf unsere derzeitige schlechte interne chronologische Auflösung zurückzuführen, die angesichts der jüngsten grundlegenden Fortschritte in der chronologischen Genauigkeit in angrenzenden Zeitabschnitten noch akuter erscheint. Diese Sichtweisen werden jedoch noch dadurch verstärkt, dass sich die Studien zum Mesolithikum auf einen veralteten und vereinfachten zweistufigen typologischen Rahmen für diesen Zeitraum konzentrieren, der mit einer kleinen Anzahl gut erhaltener Fundorte verknüpft ist, die für die Lebensweise der Menschen über Jahrtausende hinweg stehen. Diese Ansätze führen zu einem eigentümlichen Zeitmodell in den Arbeiten zum Mesolithikum. Wir argumentieren, dass wir sowohl genauere und präzisere

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Chronologien als auch erzählerische Ansätze benötigen, die die Geschichten dieser Menschen in ihrer eigenen entstehenden und unsicheren Zeit beschreiben. Um damit zu beginnen, wird in diesem Beitrag ein neuer chronologischer Rahmen für britische mesolithische Fundkomplexe vorgestellt, der auf der Zusammenstellung, Prüfung und Bayes'schen Modellierung von Radiokarbondatierungen basiert, die in angemessener Verbindung zu bestimmten Mikrolithformen stehen. Wir skizzieren auch die verschiedenen Auffassungen von Zeitlichkeit und Besiedlung für den Zeitraum von *c.* 9500–3500 cal BC.

RESUMEN

Cronología y modificaciones en el Mesolítico en Gran Bretaña 9800–3600 cal BC, por Chantal Conneller y Seren Griffiths

El Mesolítico se ha caracterizado como temporalmente homogéneo: un periodo de estancamiento o incluso degeneración en el que los grupos de cazadores-recolectores se centran en prácticas económicas rutinarias dentro de un interminable ciclo estacional. La caracterización del Mesolítico como atemporal e imperturbable deriva en parte de nuestra actual y pobre resolución cronológica interna, que parece aún más refinada dada las recientes y revolucionarias mejoras en la precisión cronológica de períodos adyacentes. Sin embargo, estas tendencias se ven exacerbadas por un enfoque en los estudios sobre el Mesolítico que se basa y simplifica en un marco tipológico bipartito, vinculado a un pequeño número de yacimientos bien preservados que se convierten en referentes de las formas de vida a lo largo de milenios. Estas aproximaciones producen un modelo temporal peculiar dentro de los estudios sobre Mesolítico. Lo que sostenemos es que se requieren cronologías más precisas y exactas así como enfoques narrativos que permitan escribir la historia de estas gentes en sus tiempos emergentes e inciertos. Para comenzar con ello, este artículo presenta un nuevo marco cronológico para los conjuntos mesolíticos en Gran Bretaña, basado en la recopilación, revisión y modelización bayesiana de las dataciones radiocarbónicas documentadas en asociación razonable con determinadas formas de microlitos. De la misma manera, también señalamos las diferentes visiones de temporalidad e inhabitación para el período abarcado entre el 9500–3500 cal BC.

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