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Dating the Justinianic Plague in England: integrating historical and archaeological data on the early Cambridgeshire region

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ABSTRACT

Archaeogenetic analysis has retrieved evidence of the presence of *Yersinia pestis*, the pathogen of bubonic plague, from graves in the Early Anglo-Saxon cemetery at Edix Hill, Cambridgeshire. Associated grave goods there, and some radiocarbon dates from Germany, suggested that the plague may have been present before the historically recorded outbreak of the 540s known as the Justinianic Plague. Targeted high-precision radiocarbon dating, however, largely confirms the conventional historical chronology. Concurrent re-examination of multiple methodological and empirical issues informatively reveals complex issues within radiocarbon data, and significant disjunctions in the phased sequence of both female and male accoutrements in this part of Anglo-Saxon England across the middle of the sixth century, when the populations were also having to accommodate themselves to the onset of the Late Antique Little Ice Age.

The 'first pandemic'

The first clearly described pandemic outbreak of bubonic plague in the western world is what has long been known as the Justinianic Plague. It struck the Byzantine Empire in AD 541 and progressed to its capital, Constantinople, by the late spring of 542. It was reported on in eye-witness detail by the courtier Procopius in Constantinople (*History of the Wars* 1914, Book 2, §§22–23) and for the Levant by John of Ephesus, whose account survives within later Syriac chronicles (trans. Pearse 2017). Other historical sources testify to the rapid spread of the plague to the westernmost parts of the Continent, Iberia and Gaul, either by sea or by land (Kulikowski 2006; McCormick 2021; Sarris 2022; Stathakopoulos 2000, 2004). Welsh and Irish annals also speak of exceptional mortalities in the later 540s, although here the relevant sources are brief and imprecise records transmitted through much later compilations (e.g. AU *s.a.* (*sub anno*) 545; AC *s.a.* 547).

Archaeogenetic analysis of human skeletal remains from Early Medieval cemeteries has recently confirmed the presence of the *Yersinia pestis* bacterium that is the pathogen of bubonic plague (most recently and fully, Keller et al. 2019). The bacterium is hosted

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by fleas which are hosted in turn in the fur of rodents – primarily great gerbils and marmots in the reservoir area of central Asia, and black rats when lethal outbreaks spread to Europe (Samia et al. 2011). For both the Justinianic Plague and the Black Death which struck 800 years later in the mid-fourteenth century, the onslaught of plague followed and was probably catalysed by major and rapid climatic changes to colder and wetter conditions (Schmid et al. 2015). Characteristically, the plague then surges in the human population in a cyclical pattern, broadly at 15–20-year intervals, until its virulence diminishes through genetic evolution within the bacterium while precautionary measures and immunity in the human population are also strengthened.

At present, I know of over 50 positive identifications of *Yersinia pestis* from more than 10 sites, not all of which may be identified at the time of writing (Figure 1). The first such identifications were from two sites within c. 20 km of each other in Bavaria

Figure 1. The cemetery sites in western Europe at which the *Yersinia pestis* bacterium has been identified.

(Feldman et al. 2016; Harbeck et al. 2013; Wagner et al. 2014). A larger sample was published by Keller et al. (2019), and more reported by Gunnar Neumann (2021) in a contribution to the conference 'The First Pandemic: Transformative Disaster or Footnote in History?' held in Hannover, in September 2021. Keller et al. (2019) reported four positive identifications from Edix Hill, Cambridgeshire, but that number has subsequently been raised to 12 such identifications from the sixth-century graves that form the basis for this paper, in which I also discuss one case where the identification is in a lower 'probable' category (all pers. comm. M. Guellil). Two further cases which imply recurrence of the plague and its associated mortality around the end of the sixth century and in the AD 664 outbreak will be presented and discussed in a further paper (Bede 1969, 3.27; Scheib et al. in prep.). In nine cases overall sufficient genomic sequencing of the bacterium has been possible, and this reveals that a specimen from Edix Hill grave 78 is a variant one SNP (single nucleotide polymorphism) ancestral to the genetic branch otherwise characteristic of this pandemic (Keller et al. 2019, fig. 2).

A total of 27 high-precision radiocarbon dates from human skeletal remains associated with positive samples were reported by Keller et al. (2019, Table S13; here S1, sorted by mean age-order). The chronological clustering of the results from some sites that is clearly evident in these tabulated data indicates that the three samples from Saint-Doulchard represent a separate outbreak of the plague, most probably in the early eighth century AD (Figure 2(a)). The remaining 24 dated samples could represent a single continuous phase of activity (A_{model} 102.9; Figure 2(b)), although it is equally clear that within that data-set the six samples from Lunel-Viel also cluster relatively late in the group, plausibly representing a local outbreak towards the end of the sixth or possibly in the early seventh century (Figure 3(a)). With both Saint-Doulchard and Lunel-Viel separated out, the remaining 18 dates reported by Keller et al. (2019) form a relatively tight population in Gaussian distribution when modelled as a single phase of burials (A_{model} 100.6; Figure 3(b)): interestingly, though, there are two dated samples from Unterthürheim which would appear to pre-date the historical record of the outbreak of the pandemic in the early 540s and have poor individual agreement with the single-phase model *First Pandemic Europe 1* (see S1: Unterthürheim 131 A:30.7; Unterthürheim 134 A:52.2).

Edix Hill, Cambridgeshire

The question of whether those early dates from Unterthürheim could be treated merely as statistical outliers, quantifying the level of imprecision that radiocarbon dating can involve, may best be addressed via a closer examination of the evidence from Edix Hill. Early Anglo-Saxon graves in a cemetery on this barely perceptible knoll in the parish of Orwell, Cambridgeshire, were first disturbed, and a few deliberately excavated, in the early to mid-nineteenth century (Babington 1860; Malim and Hines 1998, 7–11; Smith 1868). Dispersed finds from the site came to museum collections in Cambridge, Oxford, and London, variously labelled as from Malton (a nearby farm), Orwell, or Barrington. Barrington is the next parish to the east, where another large cemetery ('Barrington B') was excavated in 1880 (Foster 1883). The burial ground at Edix Hill, which came to be known as Barrington A, was rediscovered in the 1980s, and the Cambridgeshire Archaeology unit (now Oxford East) conducted excavations from 1989 to 1991 aimed at determining the extent and

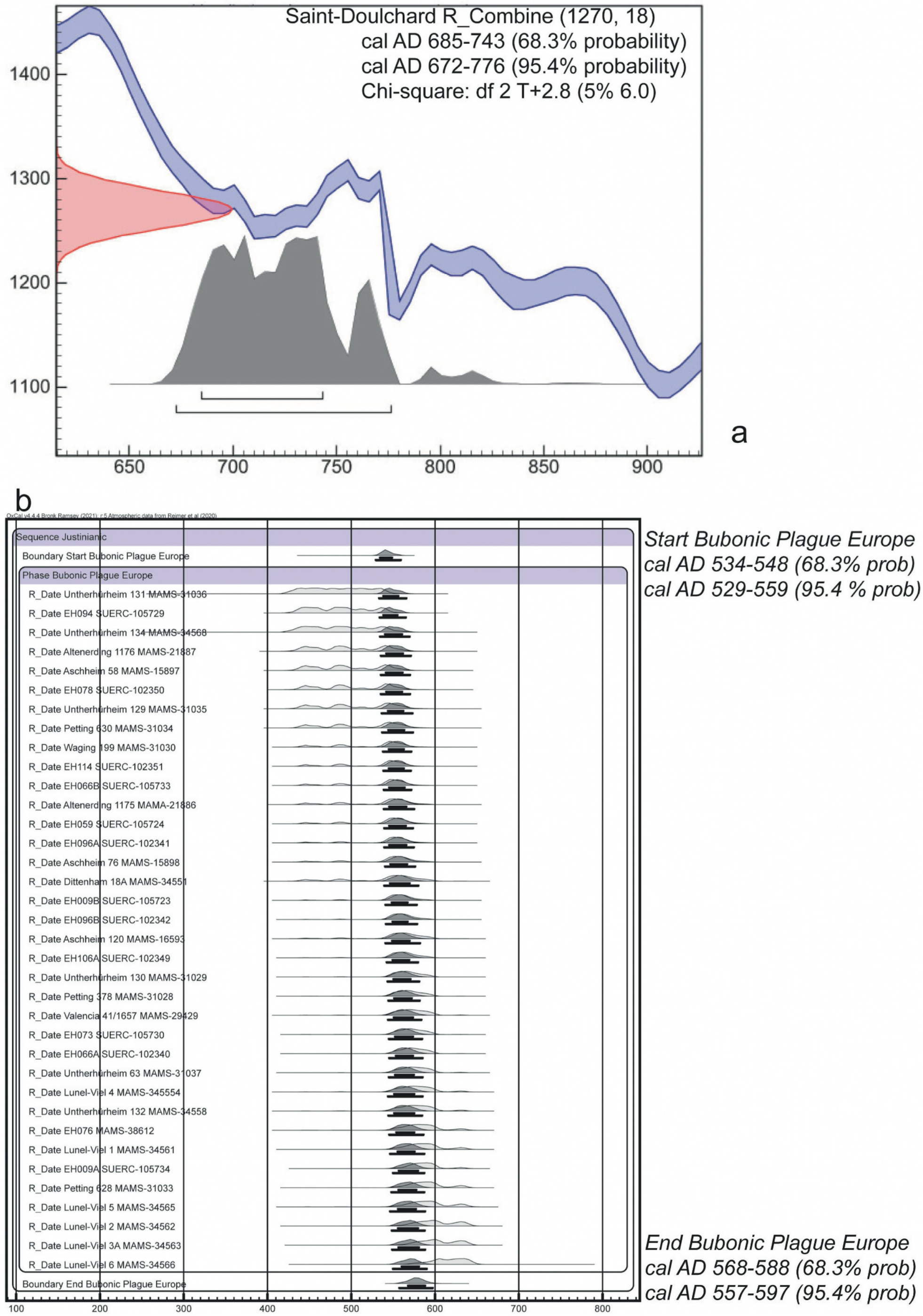


Figure 2. Chronological diagrams of a probable single outbreak and phase of bubonic plague represented by radiocarbon data. (a) Saint-Doulchard, France, all dates combined; (b) radiocarbon data from all the sites in Figure 1 except Saint-Doulchard modelled as a single continuous phase.

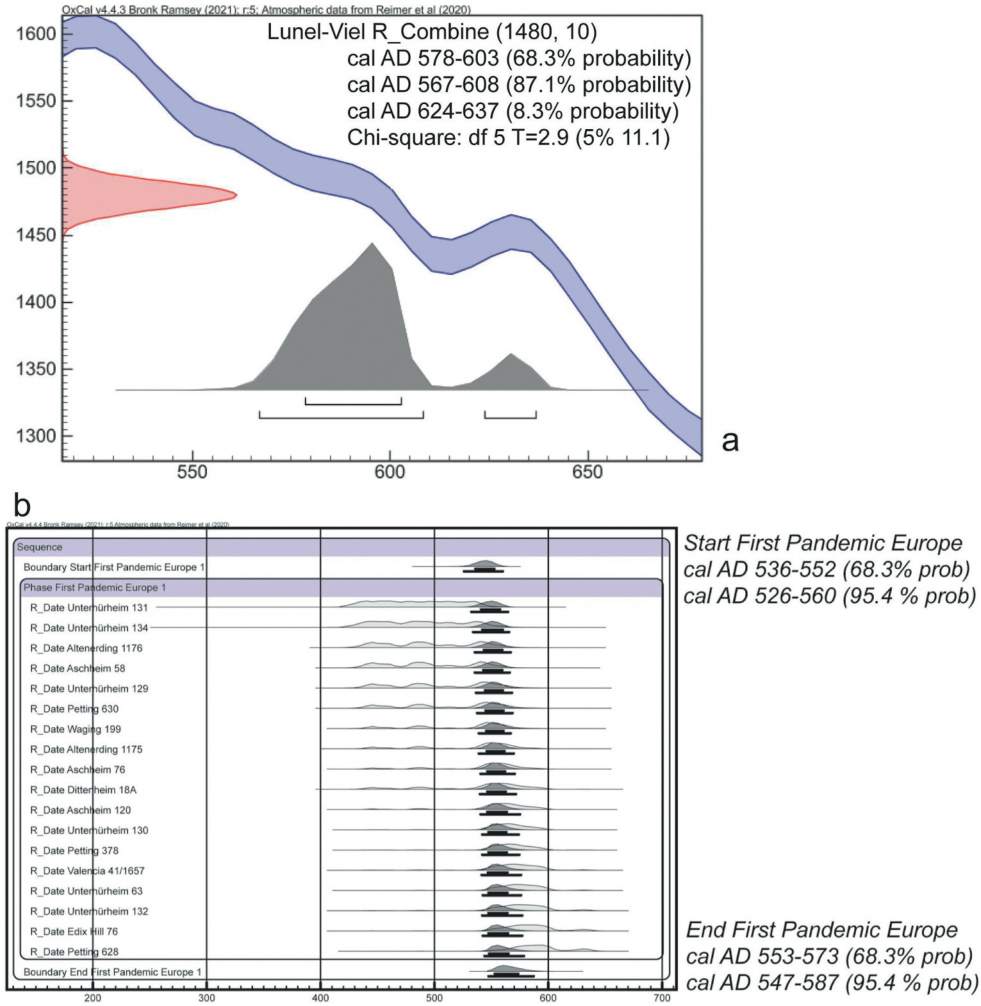


Figure 3. Chronological diagrams of a probable single outbreak and phase of bubonic plague represented by radiocarbon data. (a) Lunel-Viel, France, all dates combined; (b) radiocarbon data from all the sites in Figure 1 except Saint-Doulchard and Lunel-Viel modelled as a single continuous phase.

condition of surviving, *in situ* graves (Malim and Hines 1998). This involved the full excavation of possibly as many as 115 graves; the archaeological evidence recovered represented the interment of a minimum number of 148 individuals: no fewer than 14 graves could be identified as double or multiple burials, most of those contemporary and side-by-side but several in vertical sequences of successive interments on the same spot. There are also multiple cases of presumably redeposited human bone from previously disturbed graves. The preservation of the human skeletal remains was generally good (Duhig, in Malim and Hines 1998, 154–199). It could subsequently be inferred that the number of individual burials excavated was probably around 50% of the original number in the cemetery (Malim and Hines 1998, 227–228). Chronologically, the period of burial appeared to have spanned 150–200 years, from c. AD 500 or just before at least to the middle and possibly into the later seventh century (281–282). Further research since the 1990s has refined our chronology of Early Anglo-Saxon graves and grave goods (Hines 2021; Hines and Bayliss 2013), and we can now estimate the date of the latest identifiable grave at Edix Hill (grave 91) as *cal AD 650–675* at *95.4% probability* (Hines 2021, SM18).

The distribution of the *Yersinia pestis*-positive burials at Edix Hill is striking. Analysis and interpretation of the excavation results in the 1990s had noted that the distribution of certain epigenetic osteological traits clustered in a way that suggested zoning of the burials into household plots, with a tighter clustering of probably closely related males and wider distribution of such females consistent with a social pattern of inter-household exogamy (Malim and Hines 1998, 302–313: unfortunately figs 8.8 and 8.9 as referred to in that text were transposed in page-setting). A distinct group of graves towards the south-west of the site, many of them double burials, linearly placed in the fill of an Iron Age ditch, has a high proportion of *Yersinia pestis* identifications (Figure 4, Box A). Other positive identifications are more dispersed, but not obviously randomly scattered, with another cluster in the central area of the excavations and several apparent pairs or other correlations, as Figure 4 shows.

It was especially with the distinct south-western group that it initially appeared unlikely that a *terminus post quem* as late as AD 540 could be accepted for the burials representing this outbreak of the plague. Keller et al. (2019) had just one radiocarbon-

Figure 4. Site plan of the graves excavated at Edix Hill, Cambridgeshire, 1989–91, showing those in which *Yersinia pestis* has been identified. Red: 'positive' identifications; Orange: 'probable'. Box [A] marks the row of burials in the fill of an Iron Age ditch towards the south-west of the site.

dated grave with *Yersinia pestis* from Edix Hill, and this was one of the more dispersed examples from the north-eastern sector of the site (Figure 4, grave 76). The judgement that the burials might pre-date the historically recorded inception of the Justinianic Plague was based upon the grave goods deposited in the female graves, especially the types of beads and brooches (Table 1). These are consistently types that are *definitive* of a 'Phase A' in the seriated national chronological framework of Early Anglo-Saxon female grave goods (Hines and Bayliss 2013, esp. 459–452); more precisely, of a sub-phase F[emale]A2a within the chronological framework developed and recently refined for nearby East Anglia – that is, cemeteries in the neighbouring counties of Suffolk and Norfolk (Hines 2021; Penn and; Brugmann 2004). In the national framework, this primary phase was not investigated in any detail within itself; however it must precede the start of Phase AS-FB [= Anglo-Saxon, Female B], across a boundary modelled as falling in the range *cal AD 510–45* at *95.4% probability* (Hines and Bayliss 2013, tab. 8.2). Within East Anglia, it could be shown that the national phase AS-FB partly incorporates a regional sub-phase EA-FA2b, and a Bayesian chronological model puts the *transition EA-FA2a/AS-FB+EA-FA2b* in the range *cal AD 495–540* (*95.4% probability*) – in other words, potentially earlier than we could identify the *Start* of Phase AS-FB at a national level (Caruth and Hines 2024, esp. 333–361; Hines 2021, tab. 8; see further below). If the chronological framework and calculated date-estimates for East Anglia apply in neighbouring Cambridgeshire too, the possibility of the Edix Hill female graves in the southern group in which *Yersinia pestis* is present post-dating AD 540 would be calculated at *<2.5% probability*: statistically very low, although not zero.

The adult male and pre-teen children's graves included in Table 1 are rarely as narrowly datable to phase as those with 'adult' female grave goods (which adolescent girls could start to acquire by their early teens). No male grave concerned here contained a shield boss. A spearhead associated with a positive identification in grave 76 is of type SP5, which occurs in phases AS-MA and AS-MB of the national framework. Grave 106B is a young man who 'probably' died of bubonic plague and was buried simultaneously in a double grave with 106A (female), which is a positive identification; he was buried with a spearhead of type SP2-a2a, found in the national data-set in phases AS-MB and AS-MC. The overlap, if both these spearheads were contemporary, falls in AS-MB, which the most recent data and calculations assign to a broad range between boundaries at *cal AD 490–545* and *cal AD 540–575* at *95.4% probability*: the total range from AS-MA to the end of AS-MC, moreover, is from the fifth century up to *cal AD 560–600* at *95.4% probability* (Hines 2021, tab. 7; cf. Hines and Bayliss 2013, tab. 8.2).

Additional radiocarbon dates on the Edix Hill finds

It is therefore a set of female graves with *Yersinia pestis* that suggest a possible 'pre-Justinianic' presence of bubonic plague at Edix Hill; the male graves could either pre- or post-date AD 542 on present chronological understanding. With funding in the form of a British Academy Small Research Grant (SRG21\210678), 12 further high-precision radiocarbon dates on Edix Hill human skeletal remains directly associated with the presence of the bacterium were obtained in 2022. In two cases those involved burials

Table 1. The classified artefact-types associated as grave goods with the *Yersinia pestis* cases from Edix Hill, Cambridgeshire, along with the age and sex determinations of the individuals concerned. *Yersinia pestis* calls supplied by Meriam Guellil; age at death and sex from Duhig in Malim and Hines 1998 and Christiana Scheib (chromosomal sexing of male children).

Graves with identifications of *Yersinia pestis* (M. Guellil)	Sex and age at death	Grave goods	Stratigraphical relationships
Southern group			
66B pers. comm. M. Guellil	Female, c. 25	**Spearhead (SP2-b1a2)**; shield studs, copper-alloy vessel mounts, iron buckle	Overlain by male burial grave 66A
94 [Probable] pers. comm. M. Guellil	Male, c. 9	Bone or antler pin, iron buckle loop, and knife	
96A pers. comm. M. Guellil	Female, 25–35	**Disc brooch** and **small long brooch** (sm2); 12 amber beads, 1 **Roman glass melon bead**; copper-alloy bead tube; iron knife and belt-ring	Simultaneous burial with child grave 96B
96B Keller et al. (2019, tab. S1)	Female, 10–11	2 monochrome glass beads; copper-alloy bead tube and **scutiform pendant (PE2-b)**	Simultaneous burial with female grave 96A
106A Keller et al. (2019, tab. S1)	Female, 18–20	Pair of **5-spiral cast saucer brooches (BR2-a); glass beads (7 ConSeg)**; iron buckle and key; copper-alloy belt-ring; 2 **pairs form B13c wrist-clasps (wc-Bplate)**; 2 iron and copper-alloy studs	Simultaneous burial with male grave 106B
106B [Probable] Badillo-Sanchez et al. (2023, tab. 1)	Male, c. 18	Spearhead (SP2-a2a); iron knife; fragment of sheet copper alloy	Simultaneous burial with female grave 106A
Centre of site			
9B pers. comm. M. Guellil	Male, c. 17	Small iron buckle and larger copper-alloy buckle with backplate; shield studs; strip iron fragment	Overlain by male burial grave 9A
59 pers. comm. M. Guellil	Male, 3–4	Iron nail; copper-alloy stud; further iron fragments	
Northern area			
73 pers. comm. M. Guellil	Male, 18–25	No finds recorded	
76 Keller et al. (2019, tab. S1)	Male, c. 15	**Spearhead (SP5)**; iron buckle	
78 Keller et al. (2019, tab. S1)	Female, c. 14	**Copper-alloy annular brooch (most like BR3-d)**; 1 monochrome glass and 11 amber beads; copper-alloy buckle with backplate; **3 iron 'pan-shaped' latch-lifters**; iron belt-ring; copper-alloy and iron fragments	
80 pers. comm. M. Guellil	Male, 18–25	No certain associations	Redeposited in 'charnel pit' with remains of a child
85A pers. comm. M. Guellil	Male, 25–35	No finds recorded	Apparently contemporary with child grave 85B

(*Continued*)

Table 1. (Continued).

Graves with identifications of *Yersinia pestis* (M. Guellil)	Sex and age at death	Grave goods	Stratigraphical relationships
85B pers. comm. M. Guellil	Male, 6–7	No finds recorded	Apparently contemporary with male grave 85A
114 [Probable] Badillo-Sanchez et al. (2023, tab. 1)	Female, 17–25	17 amber beads	

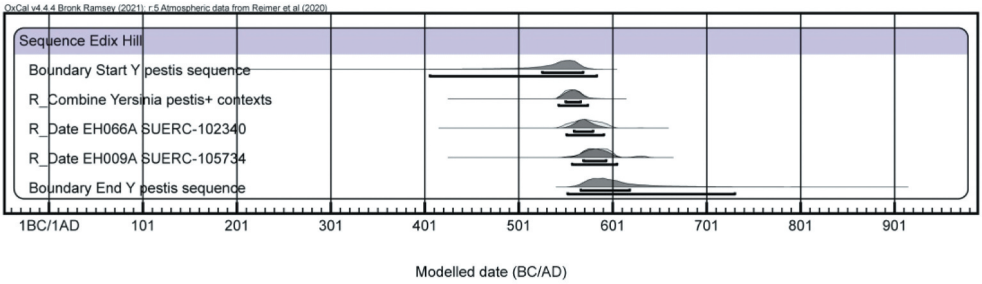
The most significant grave goods chronologically are in bold.

stratigraphically directly related to bodies that tested positive for *Yersinia pestis*, because these data can refine the modelled datings. Samples were selected and submitted for dating in consecutive batches of six so that the results of the first tranche could be reviewed and taken account of in deciding which samples to include in the second.

The results (Table 2) are unambiguous, but not as expected, in that these data give little support to the prior hypothesis that the incidence of *Yersinia pestis* at Edix Hill pre-dates AD 542. There are two results that would be consistent with that belief: from grave 85B, towards the northern end of the excavated site, and at quite the opposite side of the site from grave 94, a 'probable' case at one of the line of *Yersinia pestis*-positive graves in the south-western (ditch) row. At 95.4% probability, the former has a radiocarbon date of cal AD 416–541 (Guellil et al. 2022, fig. S9) and the latter one of cal AD 432–545. These calibrated ranges are particularly broad because of the plateau in the calibration curve (IntCal20) covering the period c. cal AD 440–540. Conversely all of the remaining results, including the date on grave 76 (Keller et al. 2019; here S1), overlap sufficiently in their probability ranges that a model postulating that they all represent a single mortality event passes the chi-square test and produces a highest

Table 2. The radiocarbon results for *Yersinia pestis* (*Y. pestis*) victims assignable to the primary outbreak of the Justinianic Plague at Edix Hill and stratigraphically associated burials. suerc-coded samples were dated with funding from the British Academy/Leverhulme trust small research grant.

Burial	Lab code	Age BP	±	*Y.pestis*	$\delta^{13}C$	Stratigraphy
Southern group						
Grave 66A	SUERC-102340	1510	16	–	−20.5	Overlying grave 66B
Grave 66B	SUERC-105733	1544	15	Positive	−20.5	
Grave 94	SUERC-105729	1577	15	Probable	−20.5	
Grave 96A	SUERC-102341	1539	15	Positive	−20.6	
Grave 96B	SUERC-102342	1529	15	Positive	−20.8	
Grave 106A	SUERC-102349	1525	16	Positive	−20.7	
Centre of site						
Grave 9B	SUERC-105723	1532	16	Positive	−20.3	
Grave 9A	SUERC-105734	1490	16	–	−20.2	Overlying grave 9B
Grave 59	SUERC-105724	1541	16	Positive	−21.4	
Northern area						
Grave 73	SUERC-105730	1512	16	Positive	−20.4	
Grave 76	MAMS-38612	1497	24	Positive	−28.7	
Grave 78	SUERC-102350	1559	16	Positive	−20.7	
Grave 85B	UB-44320	1608	27	Positive	−20.7	
Grave 114	SUERC-102351	1546	15	Uncertain	−20.6	



R_Combine Yersinia pestis+ contexts (1527,46.5)
cal AD 551-567 (68.3% probability)
cal AD 543-574 (95.4% probability)

EH066A cal AD 552-591 (95.4% probabilty); cal AD 560-580 (68.3% probablity)
EH009Acal AD 558-605 (95.4% probability); cal AD 570-594 (68.3% probability)

Figure 5. A chronological model of the dated samples of human skeletal remains directly associated with *Yersinia pestis* from Edix Hill, with male graves 9A and 66A which overlie *Yersinia pestis*-positive graves 9B and 66B.

posterior density estimate for that event in the range *cal AD 543–574* (*95.4% probability*) or *cal AD 551–567* (*68.3% probability*) (Figure 5). In this model, it is postulated that male graves 9A and 66A, overlying the *Yersinia pestis*-positive male grave 9B and female grave 66B, respectively, post-date the combined dates of all the *Yersinia pestis*-positive samples. These graves contained very similar spearheads. Grave 9A has a spearhead of type SP2-b1a3 (AS-MB/AS-MC) and is dated to *cal AD 558–605* (*95.4% probability*) or *cal AD 570–594* (*68.3% probability*) in this model, overlapping substantially with the estimated date-range of Phase AS-MC. The spearhead in grave 66A is classified as SP2-b1a2, not previously associated with any phase later than AS-MB, but the critical dimensions of this specimen place it very close indeed to the typological boundary-line between that type and SP2-b1a3. The modelled date-estimate for grave 66A here is *cal AD 552–591* (*95.4% probability*) or *cal AD 560–580* (*68.3% probability*), allowing it to fall within the calendrical date-range of AS-MB in the wider national chronological framework.

We still, however, have the radiocarbon results from graves 85B and 94, either as early outliers or as significant counter-examples. The unmodelled calibrated radiocarbon dates returned for these samples are close to the two earliest results from Unterthürheim, noted above. Either or both might represent an early outbreak of the plague here. But grave 94 lies in a neat head-to-toe row with graves 66, 106 and 95, all of which are *Yersinia pestis*-positive and fit perfectly with the conventional Justinianic Plague chronology (see Figure 4). It is implausible that grave 94 represents a chronologically separate outbreak of plague. Grave 85 is in the north-eastern zone where the *Yersinia pestis* cases are more dispersed: nonetheless three out of the six positive cases, and one uncertain but relatively probable case here, have dates which can be incorporated in the 'Justinianic Plague' combined dating model, and all of these graves have broadly the same orientation. At Unterthürheim, the unexpectedly early radiocarbon dates are on burials 131 and 134, which are two of four plague victims

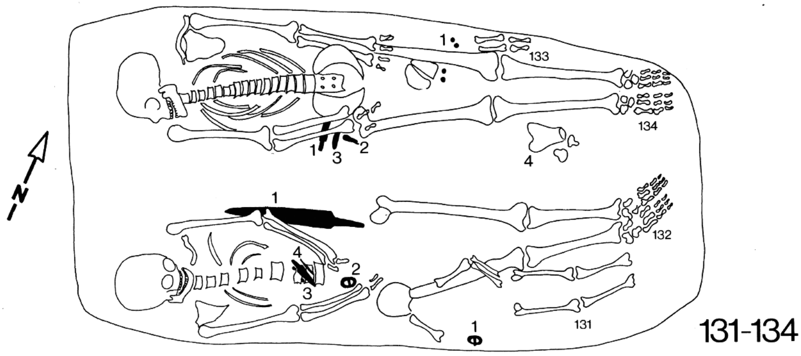


Figure 6. Unterthürheim, Bayerisch-Schwaben, Germany: burials (*Gräber*) 131–134, excavated as a quadruple interment in a single grave-pit. Burials 132 and 134 are adult males, and 131 and 133 are children. Burial 131 overlies the right leg of Burial 132 but the interrelationship of Burials 133 and 134 is unclear. From Grünewald (1988), Taf. 82, reproduced with kind permission.

interred in a specially dug grave for two adult men and two children (Figure 6; Grünewald 1988). Burial 133, the remains of a child, could not be radiocarbon dated, but burial 132 was, and the result from that body is not consistent with those from burials 131 and 134 despite the skeletons' unchallengeable contextual contemporaneity. Indeed the child's skeleton 131 directly overlay the body of adult male 132, who was interred with a seax as grave goods: not a type that is easily classifiable, in fact, as the blade-measurements fall in between the criteria defining the well-dated types *leichter* and *schwerer Breitsax*, but definitely not a type that should occur in a context of the fifth or even the first half of the sixth century (Müssemeier et al. 2003, 45–46; Siegmund 1998, 87–95). Burial 133, another small child, was buried with a set of beads comprising several specimens of the constricted segmented type characteristic of female *Yersinia pestis* graves at Edix Hill, together with millefiori types, labelled 'Mosaic' beads in Brugmann's (2004) typology, which are rare in Cambridgeshire (see below) but characteristic of the mid-sixth century in East Anglia.

The discrepancy in calibrated radiocarbon dates between graves 85B and 94 and the remaining samples is exaggerated by the plateau in the calibration curve covering the century c. cal AD 440–540. Another way of understanding the potential scientific and mathematical pitfalls involved is revealed by assessing the distribution of the radiocarbon *ages* returned rather than their calibrated dates. A pre-Justinianic outbreak of the plague should imply a bimodal distribution of the radiocarbon age-determinations for pre- and post-AD 542 datings, as epidemiologically we would expect discontinuous recurrences of the plague rather than a continuous phase of infection. A distinct early group might then comprise Edix Hill graves 85B and 94 together with the two earliest Unterthürheim results (setting aside the problem of their stratigraphic contemporaneity with burial 132, with its radiocarbon date and seax); to be followed, after a break, by the larger group comprising the data represented in Figure 3(b) here and the bulk of the Edix Hill dates. However, the Shapiro–Wilk normality test applied to the distribution of median ages reported for the samples shows that this data-set as a whole is comfortably within normal Gaussian distribution ($w = 0.9866$ where the critical threshold is $w = 0.9350$). The data as we have them thus seem to imply a single pandemic outbreak in Europe, not two distinct events. One explanation may simply be that these four early results are outliers in the specific sense that they represent the element of inaccuracy that remains embedded in the radiocarbon dating technique. The $\delta^{13}C$ figures for all four of the samples concerned here rule out any marine reservoir effect (Table 2; Keller et al. 2019 tab. S1).

However, the Shapiro–Wilk test also allows the six dates from Lunel-Viel in France to belong to a single set in normal distribution with the mass of datings that manifestly represent the primary Justinianic Plague in Europe. It is the local coherency of the cases at Lunel-Viel which identifies a separate recurrence of the plague, not the radiocarbon results alone. Conversely it is the cumulative radiocarbon evidence that convincingly refutes the suggestion (based primarily upon associated bead-types) that several *Yersinia pestis*-positive female graves at Edix Hill should pre-date the 540s. There are thus intriguing cases which might represent the circulation of *Yersinia pestis* in western Europe before the Justinianic Plague but there is no conclusive evidence that they are correctly dated earlier than the 540s.

A phased chronological framework for female graves from Cambridgeshire

The establishment of a credible chronology and archaeological profile of the effects of bubonic plague in England in the mid-sixth century is greatly enhanced by radiocarbon dating and the mathematical modelling of the results. But it depends no less fundamentally on multiple sources of evidence and understanding: artefact typology and the sequencing of grave-assemblages; historical records; and epidemiological knowledge of the behaviour of the pathogen *Yersinia pestis*. We need, therefore, also to assess the strength of a case for accepting a post-AD 542 dating for the earliest outbreak of the plague, given that the few earlier radiocarbon dates appear to be supported by comparably early-looking grave goods in the burials of females who fell victim to the plague.

The hypothesized earlier sixth-century dating was derived from chronological frameworks of indisputable relevance but which were not focussed directly upon the immediate area concerned. The national chronological framework incorporated grave-assemblages from Edix Hill and other sites in Cambridgeshire but was not designed to address the earliest range of burials, precisely because of known differences between female dress-accessories in different regions during that phase. While Phase AS-FB consistently represented across England could be modelled as covering the middle decades of the sixth century and continuing to *cal AD 555–585* at *95.4% probability* (Hines and Bayliss 2013, esp. tab. 8.2), the reconstructed and remodelled Phase EAFA2b+AS-FB, also recalibrated using IntCal20, suggests a slightly longer duration to *cal AD 565–595* at *95.4% probability* (Hines 2021, tab. 8; see also Figure 11, columns 1–2).

Despite the proximity of Suffolk and Cambridgeshire, there are some marked differences in female dress-accessories found in these two regions. The five-spiral cast saucer brooches found in grave 106A, for instance, and the disc brooch in grave 96A, are types of extreme rarity in Suffolk but frequent in Cambridgeshire. Alongside the targeted radiocarbon dating, therefore, a new chronological seriation has been undertaken for the region of Cambridgeshire. Precisely as was the case in East Anglia, in respect of male grave-assemblages the first and indeed the only test that needed to be applied is one that confirms the fit of additional material from Cambridgeshire with the national framework – which indeed already includes the data from Edix Hill, Great Chesterford, and Shudy Camps. This test does not involve many further grave-assemblages, and additional Cambridgeshire finds prove fully congruent with the existing national scheme. Most significantly, we do not here encounter any extension of the variance between the East Anglian and the national frameworks produced by disjunctions in the occurrence of shield boss-types of forms SB4-a and SB4-b and the localized survival of form SP2-b (concave-edged) spearheads (Hines 2021; cf. the discussion of grave 9A, above).

Our primary Cambridge data-matrix (S2) comprises 197 female grave-assemblages from a total of 18 sites reviewed (S3); this could include finds from the Oakington excavations of 2007–12, and in Cambridge from Croft Gardens, Newnham. The overall data-sample can be added to in the future with more detail from those sites, together perhaps with newly recovered information on the older excavations at St John's College Cricket Ground. Initially the grave goods were assessed against 161 distinct types defined in the typologies for the East Anglian and national chronological schemes together with Birte Brugmann's glass bead corpus (Brugmann 2004, tab. 11 (online)); Penn and Brugmann (2007): predominantly, in descending order of quantity, beads, brooches, and pendants, along with belt-fittings, pins, wire rings, buckets, combs, and other accessories. Of these types, 122 do occur in the Cambridgeshire data-set. One necessary and significant exclusion from the East Anglian scheme is the category of *scutiform* (pendant), which was a key type in establishing Phase EA-FA2b for Penn and Brugmann (2007) but which, without the classificational subdivisions of the national scheme, proves too general a type when the scheme is correlated with wider evidence (Hines 2021, 121–125). The new study therefore assigns scutiform pendants to the types PE2a–PE2e subdivided typologically for the national framework (Hines and Bayliss 2013, 211–212); none of those types can contribute to the seriation.

A considerable number of brooch-types can be added to the range of variables included in the East Anglian female seriation. Particular notice is due to forms that are also strongly characteristic of the regions to the south and west of Cambridgeshire while rare in Suffolk and Norfolk: disc, applied disc or saucer, and cast saucer brooches (the latter being form BR2-a in the national scheme). Another adjustment is the distinction of a category of 'square-headed' small long brooches (i.e. with square to rectangular head-plates). E. T. Leeds (1945, 8–38, esp. 26–30) noted that the earliest of these appeared to cluster in the Cambridge region. His study, based almost entirely on pre-Second World War data, is numerically heavily biased towards Cambridgeshire, which he repeatedly noted also as providing cases of developed forms of primary shapes. Square-headed small long brooches were identified as characteristic of one of contrastive female 'costume groups' at Edix Hill (Malim and Hines 1998, 313–317; regrettably, in addition to the transposition of figs. 8.8 and 8.9 in this report, figs 8.8i and ii have sides B and C of the parabola mislabelled). Also included in the Cambridgeshire female seriation are great square-headed brooches of the later range of Phase 2 (Hines 1997, 198–204: Groups II_2 and X), small square-headed, swastika, and the originally Frankish radiate-head brooches. From the national scheme, we can add two forms of pin (PI-1a and PI-1b) and the shoe-shaped belt-fitting (BU-2 h), suspended bead pendants (PE11) and double-sided combs. Following Brugmann's tabulated corpus of bead-finds, several further bead-types were also added in an exploratory manner.

These data produce a satisfactory sequence. Figure 7 shows the parabola representing the seriation by correspondence analysis of 151 grave-assemblages with reference to 75 artefact-types (S4, S5). In Figure 7(a) the grave-assemblages are shown as a phased sequence defined on the 'leading type' basis, reflecting Brugmann's sequence of Bead Phases A–C and matching as closely as possible the East Anglian phasing. Cambs-FA1 as shown here can be identified with a set of 18 grave-assemblages, many of which have the early monochrome Brown beads, and sets of five or more Blue beads. This group is, however, extremely tightly packed in respect of correspondence analysis coordinates (see Figure 7(a)), and also in this section of the seriation are simple polychrome beads corresponding with Brugmann's types Norfolk BlueWhite and Norfolk YellowRed, which belong to Phase EA-FA2a in the East Anglian scheme. Cambs-FA2a, like EA-FA2a, is dominated by 'constricted' beads ConSeg ('segmented') and ConCyl ('cylindrical'). Unexpectedly, most subtypes of Traffic Light beads fall in this area of the seriation rather than earlier. To create a category of beads to parallel the leading bead-types of EA-FA2b a combined Reticella and Melon entry has been created, but this occurs in no grave-assemblage in the Cambridgeshire sequence prior to the implicitly concurrent appearance of the Phase B bead-types Dot34 and Dot, Regular; and that is in a narrow segment of the sequence of grave-assemblages preceding the emergence of beads of the various colour schemes of the Koch20 and Koch34 types, and the form CylPen ('cylinder pentagonal'). We can treat that as a phase Cambs-FA2b+B1 for comparison with the East Anglian sequence, but in reality it locally reproduces exactly what had been identified as the national phase AS-FB. Brugmann assigned monochrome Orange and White Spiral beads to a joint phase B2-C, and in our seriation these bridge bead-sets of Cambs-FA2b+B1 and bead-sets with the classic Phase C types Annular Twist, Wound Spiral, and Doughnut, along with Amethyst and Cowrie beads. Curiously, Mosaic beads (cf. Unterthürheim burial 133, above) occur only in this segment of the seriation too. It can be labelled Cambs-FAB2+C.

Correspondence analysis demonstrates that the East Anglian female phasing is fleetingly reflected in Cambridgeshire. However, the differences between the Cambridgeshire equivalents of Phases EA-FA2b+AS-FB and AS-FC to AS-FE, and indeed the degree of variance within those phases, far exceeds that within the area covered by putative sub-phases of the preceding period: Cambs-FA1 and Cambs-FA2a in Figure 7(a). All variants of small long brooch are already present in grave-assemblages of our Cambs-FA1. Wrist-clasps of form WC-B12 are the earliest to predominate here, but form WC-B7b is also represented in this area of the seriated matrix. Cruciform brooches with lappets carrying Style I decoration, form BR-X2, are well represented here, while the simpler and traditional forms of BR-X1 unexpectedly have a later place in the sequence. As we would expect from the East Anglian scheme, wrist-clasps of forms WC-B7a and WC-bar make their appearances in Cambs-FA2a, in fact along with several other common forms of wrist-clasp included within this analysis – WC-Bplate and WC-B18c. Also appearing in this phase is the commonest form of annular brooch (BR3-c).

The sorted matrix of grave-assemblages and artefact-types (S6) reveals two other conspicuous dividing lines within the range of seriated data which may provide us with a more practical phasing of the female grave-assemblages from Cambridgeshire. Those boundaries are not defined by bead-types but by the points at which, firstly,

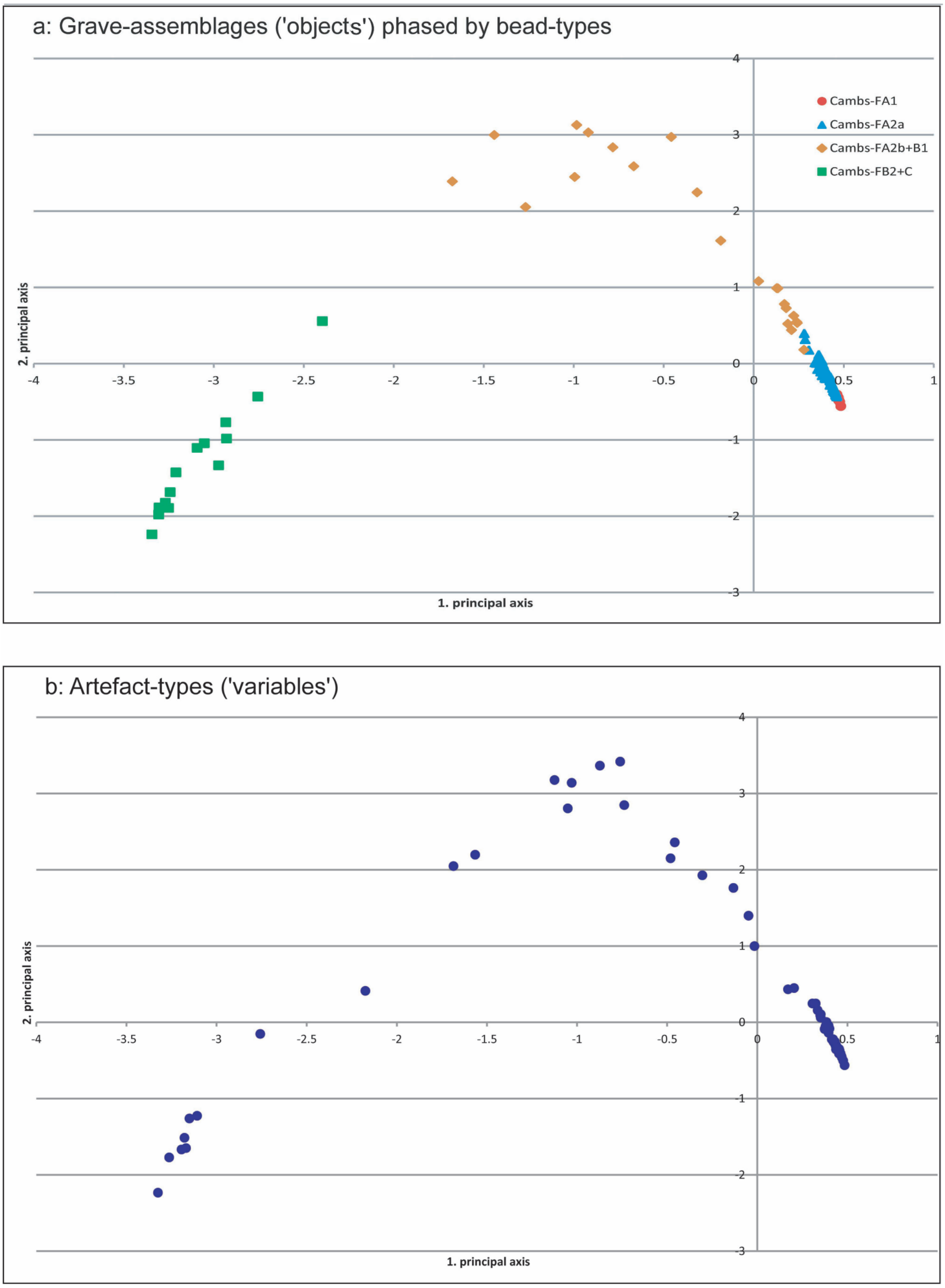


Figure 7. The results of correspondence analysis of a seriated sequence of female graves from Cambridgeshire, phased in accordance with the Cambs-F chronology as described and evaluated in the text. (a) The objects (individual graves); (b) the variables (artefact-types). For larger scale copies with data-point labels included see S5a–b.

zoomorphic-decorated applied disc or saucer brooches appear in the sequence, and then that at which cast saucer brooches appear, the latter type forming a markedly dense cluster. The cast saucer brooch (BR2-a) is consequently more plausibly characteristic of the potential Cambs-FA2b area than any bead-type.

We can then turn to the radiocarbon data and Bayesian modelling to ascertain what might be the most informative model of a phased chronological sequence of the Cambridgeshire female graves on currently available data. This yields a clear and informative result. Initially we have 22 radiocarbon-dated grave-assemblages in the seriated matrix (see S4). These radiocarbon dates convincingly represent a single continuous phase of burial activity from *cal AD 410–530* (*95.4% probability*) or *cal AD 430–495* (*68.3% probability*) to *cal AD 605–700* (*95.4% probability*) or *cal AD 650–680* (*68.3% probability*), as we should expect for burials covering the Early Anglo-Saxon Period (Figure 8; A_{model} 105.9). (For best comparison with the national chronological framework, the results of Bayesian modelling in this section are rounded out to 5-year intervals.) Within these data, the radiocarbon date for Edix Hill grave 96 (EH096) is a combined date based upon the radiocarbon ages of the two skeletons buried together, while the date of Edix Hill grave 66B is constrained by the radiocarbon date of the overlying grave 66A. The radiocarbon age of Edix Hill grave 91 (EH091) places this burial markedly later than its nearest neighbour in age-order, Melbourn grave SG69 (see Figure 8), but it still coheres within the single continuous phase.

It is manifestly fruitless to attempt to include an opening phase Cambs-FA1 in our models. The only dated burial that could represent Cambs-FA1 is Edix Hill grave 66B. EH066B and EH066A form a robust sequence, but in a model from which the highest posterior density estimates for EH066B are *cal AD 539–565* (*68.3% probability*) or

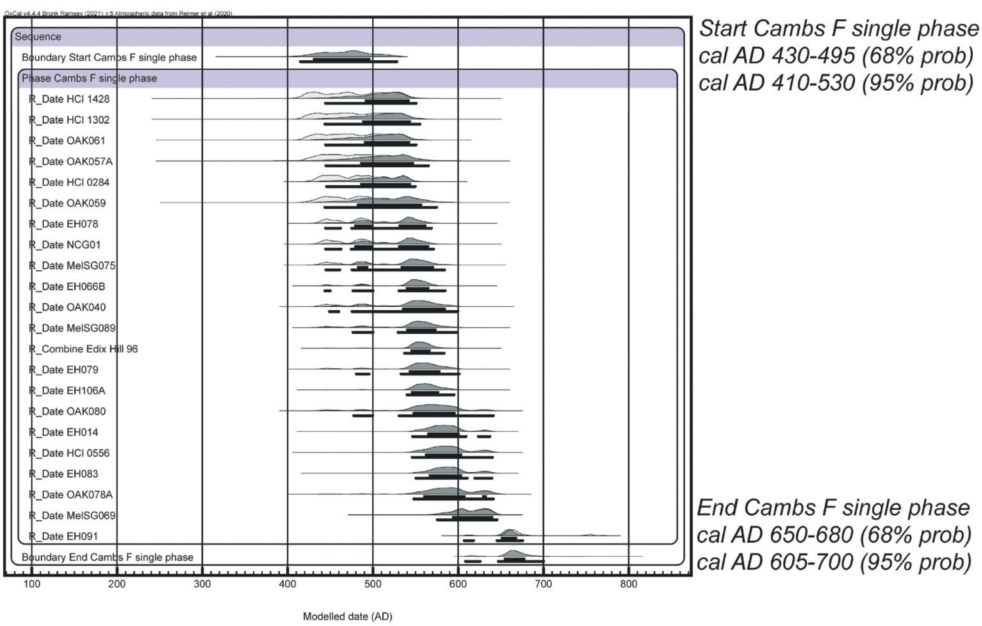


Figure 8. The radiocarbon-dated female graves from Cambridgeshire included in the seriated sequence shown in Figure 7, modelled as a single continuous phase of burial.

cal AD 530–580 (*83.3% probability*) with *12.2% probability* in the fifth century cal AD (S7: cf. above for the estimated date of EH066B modelled in relation to all of the *Yersinia pestis*-positive samples). This grave-assemblage is included in the following models in an undifferentiated Phase Cambs-FA1 + 2a.

A first subdivided model, therefore, may test the sequence of three phases as defined by bead-types described above: Cambs-FA1 + 2a/Cambs-FA2b+B1/Cambs-FB2+C (S7). With all 22 available radiocarbon dates included, this fails to achieve good agreement (S8: A_{model} 54.9), because Oakington grave 61 has very poor individual agreement at A:9.1. This grave-assemblage falls in the area of Cambs-FA2b+B1 on the strength of its cast saucer brooches, associated with wrist-clasps of form WC-Bplate, but its radiocarbon age is much higher than other graves with similar artefact-types. Especially because of the impact this apparently anomalous case may have on the crucial boundary at the start of the phase most comparable with EA-FA2b in Cambridgeshire, it seems wise to discount OAK061 as an outlier from further modelling. When that is done, the three phases with their associated radiocarbon dates (10 in Cambs-FA1+2a; 8 in Cambs-FA2b+B1; 3 in Cambs-FAB2+C), produce an entirely satisfactory result (S9: A_{model} 104.3). It is striking that there may be no representation of burials pre-dating the sixth century in this data-set (Figure 9). *Transition Cambs-FA1+2a/Cambs-FA2b+B1* is placed at *cal AD 540–575* (*95.4% probability*) or *cal AD 545–565* (*68.3% probability*) and *Transition Cambs-FA2b+B1/Cambs-FB2+C* at *cal AD 555–605* (*95.4% probability*) or *cal AD 560–590* (*68.3% probability*). *Cambs-FA2b+B1* may therefore have a relatively short duration, with the upper limit of the calculable *Span* at *23 years* (*68.3% probability*) rising to *40 years* at *95.4% probability*; the lower limits are *0* in both cases. The *End* of the whole sequence is rather imprecise with a highest posterior density estimate

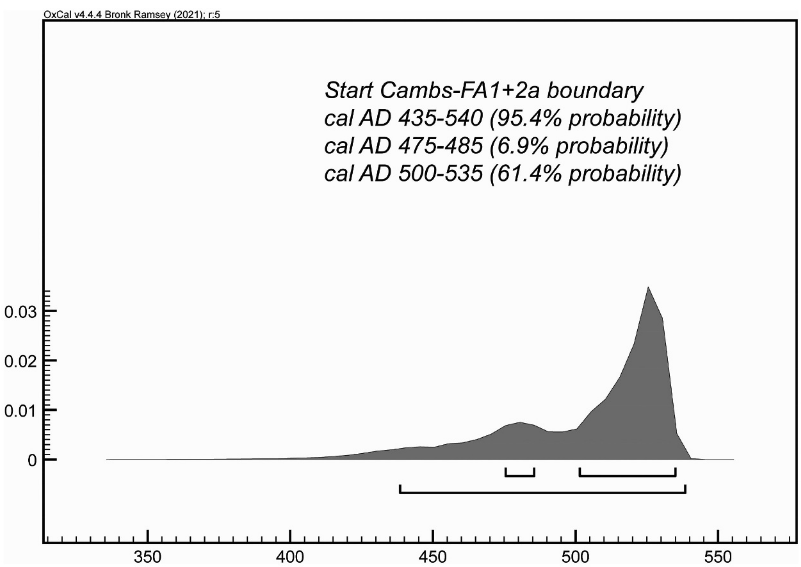


Figure 9. The distribution of probability in the highest posterior density estimate of the *Start* of phase Cambs-FA1+2a in the model of three bead-defined phases, S9.

of *cal AD 645–785* at *95.4% probability* and more usefully *cal AD 655–700* at *68.3% probability*.

To explore the comparability of the chronological frameworks that can be generated for East Anglia and Cambridgeshire further, it is possible to divide the Cambridgeshire data into four contiguous phases. Cambs-FA2b+B1 may be divided into a Cambs-FA2b characterized by the few instances of Melon and Reticella beads and slightly more Dot34 beads, and a Cambs-FB defined by the introduction of the Koch20, Koch34, and CylPen bead-types. Cambs-FC is then more precisely defined by the introduction of Amethyst, AnnTwist, Cowrie, Doughnut, and WoundSp beads, not the Orange and WhSpiral beads that run from later in Bead Phase B into Bead Phase C of the former Cambs-FB2+C. This model achieves a high index of agreement (S10: A_{model} 187.8). The highest posterior density estimates for the phase boundaries in this model are shown in Table 3 (columns 1–3). Particular attention is due to the *Span* calculations for all of these phases. Although distinct, the first three are relatively brief, and all belong essentially within the sixth century. Cambs-FC, conversely, is long, despite having fewest datable grave-assemblages.

As noted above, there are conspicuous clusterings of applied disc or saucer brooches with zoomorphic ornament (BR-ASB[zoomorphic]) and of cast saucer brooches (BR2-a) in the middle of the sequence (highlighted in the relevant columns of the spreadsheet S5). The former appear ‘earlier’ in implied order of introduction, and could, in Cambridgeshire, characterize a phase to which form gh3 girdle-hangers are restricted and in which pan-shaped latch-lifters predominate, eventually seeing the introduction of the few Melon and Reticella beads characteristic of Phase FA2b in East Anglia. Substituting a phase Cambs-FASBzoom with those zoomorphic-decorated brooches as its leading type creates a phase represented by 32 grave-assemblages in the seriated matrix as opposed to 13 in the bead-defined Cambs-FA2b. When modelling the associated radiocarbon dates, however, the difference between this and the previous bead-defined model is small: the transfer of one dated grave, EH078 (*Yersinia pestis*-positive), from Cambs-FA1+2a to Cambs-FASBzoom.

Table 3. Highest posterior density estimates of the boundaries in two variants of a four-phase model of the Cambridgeshire female burial sequence with the definition and boundary of the third phase varied as described in the text, and the estimated spans of the phases.

Phase-boundary	*95.4% probability cal AD*	*68.3% probability cal AD*	Phase-boundary	*95.4% probability cal AD*	*68.3% probability cal AD*
Start Cambs-FA1+2a	*490–545*	*515–540*	*Start Cambs-FA1+2a*	*485–545*	*515–540*
Transition Cambs-FA1+2a/ Cambs-FA2b	*540–565*	*545–560*	*Transition Cambs-FA1+2a/ Cambs-FASBzoom*	*540–565*	*545–560*
Transition Cambs-FA2b/ Cambs-FB	*545–580*	*550–570*	*Transition Cambs-FASBzoom/ Cambs-FB*	*545–580*	*550–570*
Transition Cambs-FB/ Cambs-FC	*555–615*	*565–595*	*Transition Cambs-FB/Cambs-FC*	*555–615*	*565–595*
End Cambs-FC	*645–745*	*655–690*	*End Cambs-FC*	*645–740*	*655–690*
Span			Span		
Span Cambs-FA1+2a	*3–58 years*	*12–33 years*	*Span Cambs-FA1+2a*	*0–55 years*	*8–33 years*
Span Cambs-FA2b	*0–18 years*	*0–9 years*	*Span Cambs-FASBzoom*	*0–19 years*	*0–10 years*
Span Cambs-FB	*0–34 years*	*0–18 years*	*Span Cambs-FB*	*0–35 years*	*0–19 years*
Span Cambs-FC	*24–94 years*	*52–85 years*	*Span Cambs-FC*	*24–95 years*	*52–85 years*

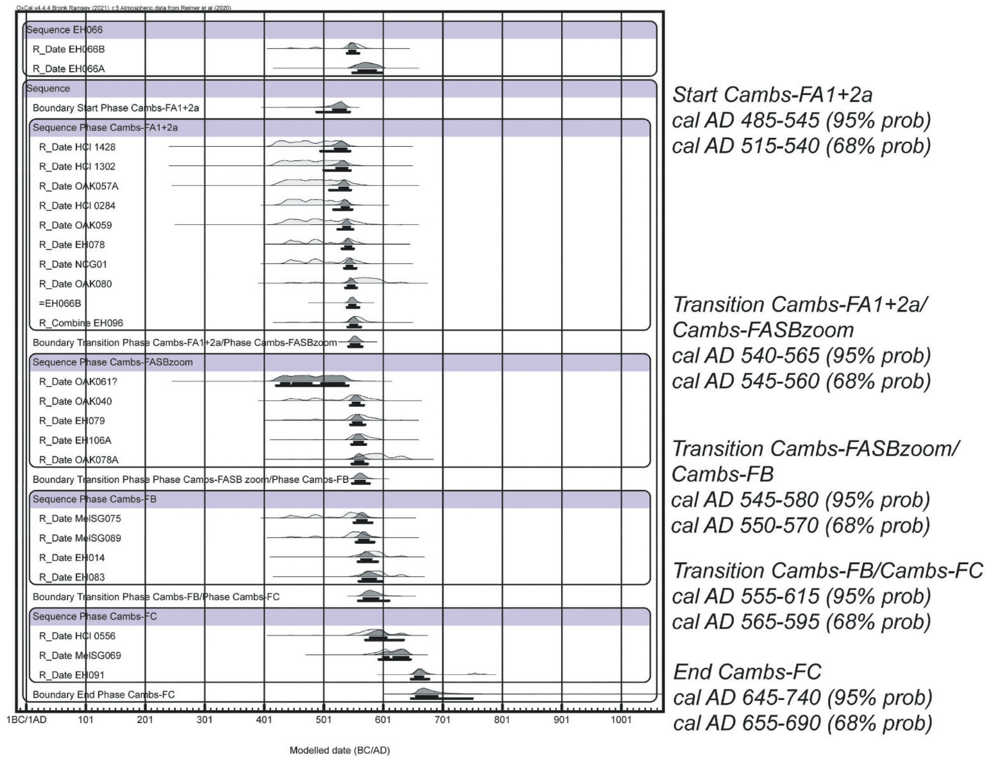


Figure 10. A four-phase model of the Cambridgeshire female grave sequence, including a phase cambs-FASBzoom, as described in the text.

This model also has excellent agreement, A_{model} 158.4 (S11; Figure 10), and the highest posterior density estimates for the phase boundaries are almost identical, except marginally in the *95.4% probability* ranges for the *Start* and *End* of the sequence. The *Span* calculations are unchanged (Table 3, columns 4–6).

A summary and reflections

Although the archaeological data returned from the modern professional excavations and post-excavation analyses of the Edix Hill cemetery are substantial and informative, this is evidence from a partially excavated site that was considerably disturbed in the nineteenth century, and only cautious estimates can be made of the size of the burying community that it represents. Such estimates nevertheless plausibly suggest a population of around 45 to produce the observed and inferrable number of graves in this cemetery, with an age structure that sets the size of the 'reproductive generation' within that community at around 25 (Malim and Hines 1998, 227–228, 292–293, modified in light of the firmer date for grave 91 assigned to the female phased sequence). There is a firm case to be made that at least 13 of these fell victim to the same outbreak of pestilence, and thus died at what may be treated as the same time.

Against an estimated population figure of 45, this represents a minimum mortality level of 29% in the initial Justinianic outbreak.

The age and sex structure of the group of victims is informative. Duhig was able to infer the sex of all the adolescents and the adults, and indeed the younger children too can now be sexed chromosomally (pers. comm. C. L. Scheib). Overall there are more males than females, but the difference is statistically insignificant. None of these victims has an estimated age at death over 35, implying that the impact on the reproductive generation of the community was substantial. We may nevertheless conclude that there was no significant selectivity in susceptibility to the plague, and that its victims represent a random cross-section of the community.

At the same time, while the group of burials in the south-western ditch-fill (Figure 4 [A]) strongly suggests a catastrophic outbreak in one particular household and the need to bury some victims concurrently, others in very close succession, the structure of the cemetery and the character of the graves imply that the community managed to absorb these sudden losses in terms of maintaining its usual funerary practices. The southern ditch group might be separated from its nearest neighbours in the cemetery by more than 15 m (see Figure 4), but discrete household groups are themselves regular features of the overall cemetery layout.

In a wider perspective, this evidence of natural but extreme mortality associated with a historically identifiable event reveals a differentiation in cultural practice between neighbouring regions of sixth-century England that would not otherwise have been perceived. That differentiation is represented in the accoutrement of both sexes as adults, even if, in respect of males, the contrast resides only in a regional peculiarity in the chronological distribution of shield boss- and spearhead-types in East Anglia not being shared in Cambridgeshire. The regional contrast is more marked in the dress-accessories which dominate the grave goods of adult females. This is a facet of material culture in which 'identity' is often positively and purposefully embedded (Røstad 2021).

There is no obvious explanation of why we can barely pick out an initial phase FA1 in Cambridgeshire, in contrast to East Anglia. The brooch-types and wrist-clasps that dominate EA-FA1 are well represented in Cambridgeshire, so it is hardly plausible that this is attributable to a later establishment of a proto-Anglo-Saxon population and culture in Cambridgeshire, with fifth-century finds barely represented there. Nonetheless, our modelled sequence of radiocarbon-dated graves starts in the sixth century rather than the fifth (Figures 8 and 9, Table 3). For the time being, this can be highlighted as an anomaly to assess further as additional evidence becomes available and further analyses possible.

In East Anglia, Phase EA-FA2b is strongly marked by the introduction of the distinctive, highly uniform, and numerous Group XVI great square-headed brooches, associated with related but different, serially reproduced designs in Groups XVII and XVIII (Hines 1997, 118–145). A counterpart in Cambridgeshire might be expected to be Group XV (111–118), but those brooches do not have the presence in the data-set to fulfil this function in the chronological seriation. In East Anglia, the great square-headed brooch-types referred to coincide with the introduction of new glass beads, the Melon and Reticella types. James Peake's analyses have shown that these bead-types came into use along with a new variant of glass, EMedII. That was essentially new glass manufactured in bulk in the Near East, and modified with the addition of plant ash on the Continent or in England (Peake in Caruth and Hines 2024, 421–433). The start of EA-FA2b is thus a significant threshold in the sequence of manufacture and distribution of glass beads in England (Hines 2017), and it has a modelled date-estimate before *cal AD 540* at *95.4% probability*.

In Cambridgeshire, by contrast, the most substantive phase lying between a phase with types common to EA-FA1 and EA-FA2a and the phase -FB dominated by types common to East Anglia and Cambridgeshire and indeed in the national sample is defined by the adoption of variants of saucer and disc brooch formerly characteristic of the areas to the west and the south in England – in Sussex and the embryonic Wessex. Our modelled radiocarbon data place the emergence of this phase around the middle of the sixth century, implying that material characteristic of the preceding phase remained in use in Cambridgeshire for around a generation longer than in East Anglia (Figure 11). An important insight provided by the present study is that we can now locate the previously unconnected Cambridgeshire Costume Group A characterized by these brooch-types within what, 25 years ago, had appeared to be an 'abrupt watershed' between earlier and later ranges of material in this region (Hines 1999b, 68–72; Malim and Hines 1998, 313–317).

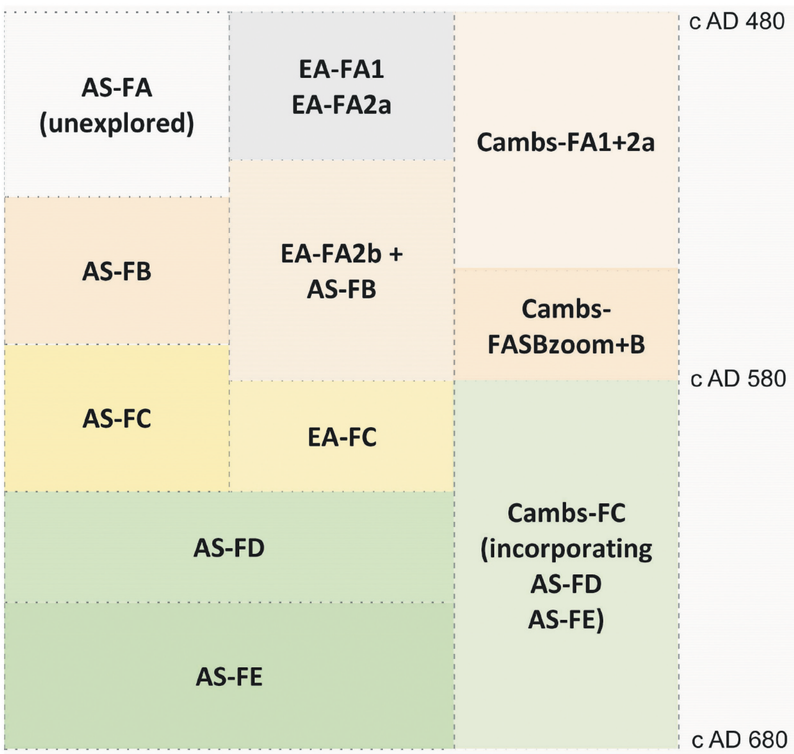


Figure 11. A schematic diagram illustrating the relationship between phased sequences of female burials in the national chronological framework (AS-) and East Anglian regional scheme (EA-) along with the three-phase model of the Cambridgeshire female grave sequence (Cambs-) as reported in Table 4. For the sake of clarity, an approximate median point from the highest posterior density estimate ranges has been selected for the horizontal lines representing phase boundaries.

For maximal calendrical comparability with the East Anglian scheme (Hines 2021), we need a model matching Phase EA-FA2b+AS-FB with one that is Cambs-FASBzoom+FB. This produces highest posterior density estimates for *Start Cambs-FASBzoom+FB* at *cal AD 540–565* (*95.4% probability*) or *cal AD 545–560* (*68.3% probability*) and *Transition Cambs-FASBzoom+FB/Cambs-FC* at *cal AD 555–605* (*95.4% probability*) or *cal AD 565–590* (*68.3% probability*) (S12; Table 4). Those results confirm that the Cambridgeshire and East Anglian sequences re-converge during the later part of the period covered by Phase AS-FB in the national framework, so that the subsequent composition of female grave-assemblages is fundamentally the same in Cambridgeshire, East Anglia, and indeed much of the rest of Early Anglo-Saxon England.

However scientifically and mathematically sound, modelled estimates of prominent material cultural watersheds such as these can only be as good as the quality and quantity of the data put into them allow. Further evidence will surely adjust them in the future. But it is clear that the sequence of material cultural phases in Cambridgeshire and East Anglia through the middle of the sixth century diverged, and there is no reason why the principal transitions should not have differed in date to the extent implied by the present modelling. In the case of Cambridgeshire, the transitional phase separating Cambs-FA1+FA2a and Cambs-FC apparently closely *followed* the crises faced by the population after the climatic disasters of AD 536 and following years, including the Justinianic Plague of the 540s. In East Anglia, conversely, the chronological evidence implies that a major material cultural reorientation had set in *before* those blows. It is intriguing if specific, environmental and natural, determinism was operative in the former case and not in the latter except in so far as it may have crystallized a direction of change already underway.

It is concurrently important to appreciate the diversity and weight of evidence for shared material and social exchanges between the Cambridgeshire region and areas to the north and west in the central and southern Midlands in the earlier sixth century that apparently embody an early network of connexions and relationships which from the mid-seventh century was politicized, by royal *fiat*, as a kingdom and diocese of the Middle Angles (Hines 1999a). By the final decades of the seventh century this territory had absorbed and extinguished the earliest West Saxon (Gewissean) bishopric at Dorchester-on-Thames, Oxfordshire. The contested character of the area immediately to the west of Cambridgeshire is implied by the Chronicle record of a Battle of Bedford in AD 571 by which a West Saxon royal, Cuthwulf, won control over a territory dominated communicatively by the Icknield Way and Akeman Street between the

Table 4. Highest posterior density estimates of the boundaries in a three-phase model of the Cambridgeshire female burial sequence with phases Cambs-FASBzoom and Cambs-fb shown in Table 3 combined into one phase for comparability with phase EA-FA2b+AS-FB (Hines 2021).

Phase boundary	95.4% probability	68.3% probability
Start Cambs-FA1+2a	*cal AD 480–545*	*cal AD 510–540*
Transition Cambs-FA1+2a/Cambs-FASBzoom+B	*cal AD 540–565*	*cal AD 545–560*
Transition Cambs-FASBzoom+B/Cambs-FC	*cal AD 555–605*	*cal AD 565–590*
End Cambs-FC	*cal AD 645–765*	*cal AD 655–695*

Upper Thames and the River Lea (ASC 1996, MS A, *s.a.* 571). The date assigned to this event in the Parker Chronicle cannot be treated as reliable, but it does coincide plausibly with a period of successful military expansion and consolidation of Gewissean royal power, both eastwards and westwards (Yorke 1990, 132–142). What we can now also see is that that followed a recent phase of reorientation towards the south and west in the material culture of the dominant free stratum of society in the Cambridgeshire region, rather than preceding and therefore conceivably causing it.

We might call this a classic case-study in historical archaeology. A precisely dated, documented event can be identified with a series of chronological horizons at a particular archaeological site, and exploration of further questions this raises brings both deep and broad diachronic and spatial patterns into clear view. We can concurrently start to unfold what that event actually meant in practice for this community. Contextually, there is an astonishing breadth of facets to what we can plot and compare as sequences of cause, effect, and change – in such a way as takes us away from simplistic, monocausal determinism and reveals complex patterns of interaction. This sort of research can only be produced through collaboration between specializations, and the ready sharing of results. Especially to be stressed is the value and the necessity of embedding osteoarchaeology and biomolecular archaeology fully within longer-standing traditions of the study of material culture and historical processes.

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Disclosure statement

No potential conflict of interest was reported by the author.

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