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Regional variation in the continuity of land-use patterns through the first millennium A.D. in lowland Britain

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Abstract

This paper explores the contribution that palaeoenvironmental evidence, and in particular palynology, is making to our understanding of landscape evolution in Britain during the 1st millennium A.D. This was a period of profound social and economic change including a series of invasions, some associated with a mass folk migration. Archaeologists and historians continue to debate the significance of these events, and palaeoenvironmental evidence is now starting to provide an additional perspective. Key to this has been obtaining pollen sequences, although there remains a need for more evidence from lowland areas, alongside higher resolution sampling and improved dating. It is suggested that although the 1st millennium A.D. saw some significant long-term shifts in climate, these are unlikely to have had a significant causal effect on landscape change in lowland areas (both in areas with and without significant Anglo-Saxon immigration). The analysis of pollen data from across Britain shows very marked regional variations in the major land-use types (arable, woodland, improved pasture, and unimproved pasture) throughout the Roman and early medieval periods. While Britain ceasing to be part of the Roman empire appears to have led to a decline in the intensity of agriculture, it was the 'long 8th century' (the later 7th to early 9th centuries) that saw a more profound change with a period of investment, innovation, and intensification including an expansion in arable cultivation.

INTRODUCTION

Documentary sources tell us that the 1st millennium A.D. was an era of profound social and political change, with most of the island of Britain being incorporated within the Roman empire and then a series of invasions from mainland Europe that comprised the Anglo-Saxons (in the 5th century), the Vikings (in the 9th century), and the Normans (in the 11th century). Historians have in the past argued that these events brought about some profound transformations of the British landscape, and until the 1960s archaeologists also believed that changes seen in the countryside could be explained by invasions and migrations. In recent decades, however, our understanding of the Roman and early medieval periods in Britain has shifted as the primacy of documentary-based frameworks has been challenged by the development of landscape-based approaches towards studying the past and the longer-term perspectives that they provide. Archaeological evidence has confirmed that these invasions took place, and although the scale of any associated mass folk migrations has been much debated the consensus is that the number of immigrants was small compared to the surviving native population. As such these invasions are best seen as short-term events that were simply one of many factors that were shaping landscape change.[1]

The integration of palaeoenvironmental work with other archaeological techniques has been an important part of this new landscape-based approach, and this paper will review the contribution that pollen analysis has made. By the 1980s it was starting to have an impact on our understanding of what happened in Britain following the cessation of Roman rule, with Martin Bell suggesting that there may not have been a large-scale regeneration of woodland in the 5th century as had traditionally

[1] see Rippon *et al*. (2015) for a full discussion and further references

been assumed.[2] In 2000 Petra Dark brought together the evidence from sites dated to both the Roman and the early medieval periods, although it was noticeable just how few pollen sequences there were from lowland areas.[3] Another problem with the use of palaeoenvironmental data in the 1st millennium A.D. has been the lack of dialogue between archaeologists and palaeoenvironmentalists. This is a two way problem. Archaeologists need to make greater use of pollen evidence and Ken Dark's[4] recent review of Dumnonia (South West England), for example, fails to make use of the large number of published pollen sequences from that region which now cover this period even though they would have supported his argument for a period of 'Late Antiquity'. Palynologists also need to engage more with archaeologists in order to understand how changes in land-cover described by their pollen data reflect patterns of land use. This is a particular problem if different land-use systems result in the same 'pollen-eye' view of land cover, such as wood pasture systems that may be indistinguishable from woodland management for charcoal production. Palaeoclimate scientists also need a far better understanding of the archaeological and historical evidence for the periods they are studying in order to avoid over-interpreting the correlations they are noting between climatic events and cultural phenomenon (see below).

The rest of this paper will explore the contribution that pollen analysis has made to our understanding of the British landscape during the 1st millennium A.D., focussing on the area south of Hadrian's Wall (that marked the northern frontier of the Roman province of Britannia). It begins with a summary of the major developments in Britain's landscape history, and then considers the range of pollen data that exists. The different geographical scales of analysis are considered, as well as the problem of temporal resolution. An attempt to study land use at a regional scale is introduced, and its results calibrated against an independent documentary source (the 11th century Domesday Book). Changes and continuities in land use are then explored at a regional level followed by two case studies.

THE 1ST MILLENNIUM A.D.: AN ERA OF TRAUMA IN THE COUNTRYSIDE?

The 1st millennium A.D. was an era of profound change in the countryside of Britain. Although an island on the western edge of the Roman empire, lowland Britain was generally a highly Romanized and wealthy area with a well-developed market economy and urban hierarchy. The lowland countryside was densely settled and agriculturally highly productive,[5] and even the upland areas had been extensively cleared of trees and must have been regularly grazed by livestock in order to prevent woodland regeneration.[6] There has been much debate about what happened when Britain ceased to be part of the Roman empire in the first decade of the 5th century A.D., with some favouring a sudden and catastrophic collapse of the market-based economy and then a mass folk migration of Angles and Saxons from mainland Europe, and others arguing for a more gradual period of change.[7] What happened in the 5th century must, however, be seen within the context of what went before, and instead of the Roman period being one of spatially uniform and temporally stable landscape character and land management practices, it is now recognised as having seen significant variations in settlement patterns, animal husbandry, arable regimes, and economic prosperity across both time and space.[8]

[2] Bell (1989)
[3] Dark (2000)
[4] Dark (2014)
[5] Smith *et al*. (2016)
[6] Rippon *et al*. (2015)
[7] see Esmonde Cleary (2014) and Rippon *et al*. (2015) for historiographies
[8] Rippon *et al*. (2015) 74-85; Smith *et al*. (2016)

The concept of a ‘Late Antique’ period in Britain is poorly developed, in part because in the past there has been a tendency to see a relatively abrupt and complete end to Roman Britain (as part of the ‘culture-historical’ approach towards interpreting the past that saw Roman Britain as quickly invaded by large numbers of Anglo-Saxons).[9] There have always been some scholars, however, who have seen threads of continuity within the landscape, although most of this evidence has been recognised in western Britain.[10] There is currently a continuum of opinions from those who still see a mass folk migration replacing the native British population with an Anglo-Saxon one, through to those who argue for very limited Anglo-Saxon immigration. In the former camp are linguists and place-name scholars,[11] and that the starting point of a major conference in 2004 examining *Britons in Anglo-Saxon England* was ‘whether or not there were many Britons within Anglo-Saxon England’[12] is telling, particularly as many of the papers – particularly those by linguists – rejected the notion of any significant British survival. At the other extreme are the likes of Pryor who goes as far as to argue that 4th to 6th century England had ‘an essentially stable rural population existing in a political context that was changing quite rapidly’, with ‘no convincing archaeological evidence for “Dark Age” chaos, disruption or turmoil’, and that ‘Anglo-Saxon mass migrations into Britain never happened’.[13]

Since the 1980s, however, most archaeologists have argued that rather than a complete displacement of the native British population, it was a relatively small number of Angles and Saxons that achieved political supremacy through a military and political conquest.[14] Although there has been little agreement on the scale of the Anglo-Saxon immigration, with estimates ranging from 50,000-100,000 to ‘no more than 10,000 Saxon settlers’,[15] these numbers are low compared to estimates for the size of the native Late Romano-British population that are currently around 2.5 to 3.7 million.[16] New analysis of genetics data from modern rural communities in Britain has recognised distinct ancestral populations, with a south and central England group strongly influenced by Anglo-Saxon migrations, and the study by Leslie *et al*. 'limits the proportion of Saxon ancestry, clearly excluding the possibility of long-term Saxon replacement' and estimates the proportion of Saxon ancestry as most likely in the range of 10-40%.[17] That dynasties claiming Anglo-Saxon ancestry eventually achieved political supremacy across England is certainly borne out by the documents that survive from this period – written from the perspective of the ascendant immigrant population it must be remembered – and these same documents do record the survival of a native British population albeit subservient to their Anglo-Saxon masters (e.g., the Law Code of King Ine of Wessex dated *ca*.688-93).[18] The fate of the native Romano-British population – the ‘invisible Britons’[19] – in eastern England has, however, seen little consideration by archaeologists.

While the scale and significance of change as Britain ceased to be part of the Roman empire is unclear, there is no question that many of the higher status components of the Romano-British landscape – its towns and villas – as well as its market-based economy and manufacturing industry disappeared in the 5th century, and this will have adversely affected agricultural production, something that is supported by the pollen evidence (see below). From the later 7th to early 9th

[9] e.g., Jones (1996); Esmonde-Cleary (1989); Faulkner (2000)
[10] e.g., Finberg’s (1955) study of Withington in Gloucestershire, and Bonney’s (1972; 1979) and Fowler’s (1975) work in Wessex
[11] e.g., Gelling (1993); Coates (2007)
[12] Higham (2007b) 1
[13] Pryor (2004) 96, 214
[14] e.g., Arnold (1988); Hodges (1989); Higham (1992); Dark (2000); Henig (2002)
[15] Alcock (1971) 311; Jones (1996) 26; Taylor (1983) 111
[16] Fowler (1983) 8; Millett (1990) tab. 8.5; Higham (1992) 20; Mattingly (2011, 220); Williamson (2013) 12-13
[17] Leslie *et al*. (2015), 313
[18] Grimmer (2007)
[19] Coates (2007)

centuries – what has been referred to as the 'long 8th century' – however, there are various strands of evidence for an economic revival. This included an intensification of agriculture within the context of the emergence of relatively stable kingdoms, and a revival of international and inter-regional trade through coastal emporia and a series of smaller inland settlements (that have become known as 'productive sites' due to the large amounts of coinage that they have produced) .[20] This period also saw investment in infrastructure such as grain storage and processing facilities at estate centres,[21] the construction of causeways in order to improvement communications,[22] and intertidal fish traps.[23] This period also marks the start of a major transformation of the landscape through the nucleation of formerly dispersed settlement patterns into villages, and the restructuring of field systems in order to create open fields, across large parts of central England.[24]

This period of expansion and innovation was brought to an end by the Viking incursions of the 9th century, although stability was re-established by the English re-Conquest of the Danelaw in the early 10th century. The mid-11th century brought about a final invasion – the Norman Conquest – and although in southern England this appears to have had a limited immediate impact on the landscape, the 'Harrying of the North' may have had a lasting legacy with the replanning of many landscapes; the limited pollen evidence for the impact of the Norman Conquest is discussed elsewhere.[25]

THE CAUSES OF CHANGE: CLIMATIC AND SOCIAL CHANGES

There has been much debate about the relationship between society and the natural environment. There was a time when environmental factors were thought to have determined human behaviour,[26] although such views went out of fashion within archaeology and 'environmental determinism' became a much derided stand-point.[27] In recent years, however, there have been nuanced considerations of how topography may have shaped the settlements and field systems of early medieval England,[28] and an exploration of the extent to which Romano-British and early medieval animal husbandry and the cultivation of arable crops may have been influenced by geology and soils.[29] Major changes in climate – particularly in more physically and environmentally challenging areas – may also have influenced human behaviour, although there are great dangers in making simplistic correlations between climatic events evidenced in one area and societal changes seen elsewhere. Middleton, for example, has argued that 'paleoclimatic studies have already profoundly impacted the study of collapse and culture change', and goes on to warn that 'a new determinism is in evidence'.[30] While past reconstructions of past climate used to be based on scarce and very indirect evidence, [31] recent advances in a wide range of scientific techniques are starting to provide more

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[20] Hanson and Wickham (2000); Wickham (2005); Rippon (2010)
[21] e.g., corn driers at Hereford (Shoesmith 1982; Thomas and Boucher 2002); Higham Ferrer, Northants (Hardy *et al*. 2007); watermills at Ebbsfleet in Kent (Andrews *et al*. 2011) and Tamworth in Staffordshire (Rahtz and Meeson 1992, 1)
[22] e.g., across the Thames at Oxford, linking Mersea Island to the mainland of Essex, and at Skerne in the Hull valley, and at Glastonbury in the Somerset Levels (Durham 1977; Crummy *et al*. 1982; Dent *et al*. 2000; Brunning 2014)
[23] e.g., the Thames Estuary, Norfolk coast, and Blackwater Estuary in Essex (Cowie and Blackmore 2008, 115-24; Murphy 2010; Rippon 1996; Hall and Clark 2000)
[24] The origins and development of villages and open field remains much debated: for recent discussions see Lewis *et al*. (1997); Roberts and Wrathmell (2002); Williamson (2003); Rippon (2008); Williamson *et al*. 2013
[25] Creighton and Rippon (in press)
[26] e.g., Postan (1972); Burgess (1985)
[27] e.g., Wright (1976)'s dismissal of climate change as a causal factor in the desertion of late medieval villages
[28] Williamson (2003; 2013); but see Lowerre (2014) for a critical assessment.
[29] Rippon *et al*. (2014; 2015)
[30] Middleton (2012), 268; and see Coombes and Barber (2005).
[31] summarised in Lamb (1982)

reliable evidence for both precipitation and temperature, although there remains a need to take great care in interpreting the results. Palaeoclimate reconstructions rely upon scientific techniques whose resolution is rarely as good as for the documentary sources we have for this period, and they are also invariably based upon data from physically 'marginal' landscapes that were well away from core areas for human settlement (ie the lowlands). Buntgen *et al*.'s data, for example, does indeed appear to show a decline in summer temperatures from the mid-6th through to the mid-7th centuries in the European Alps and Russian Altai-Sayan Mountains, but did this really constitute a 'Late Antique Little Ice Age' that was a contributing factor 'to the establishment of the Justinian Plague, transformation of the eastern Roman empire, and collapse of the Sasanian empire'? [32] Buntgen *et al*.'s data is from very high upland areas and it is very unlikely that climate changes there will have been uniform across the rest of Europe, and in lowland areas in particular the impact of slight changes in climate will also have been far less significant than in upland areas where a shortening of the growing season by a few days could prove critical.

Figure 1 brings together a range of recent palaeoenvironmental data compilations that describe climate during the 1st millennium A.D. Whilst there are significant challenges in making such syntheses, including dealing with uncertainties within chronologies from different studies, discrepancies between different climate indicators, disentangling the climatic drivers and how they are reflected in the records, and the geographic area reflected in the reconstructions, they provide the best current understanding of climatic changes in both mainland Europe and Britain. Charman *et al*. have synthesised bog-surface wetness records derived from testate amoebae assemblages from ombrotrophic (i.e., rain-fed) bogs across northern Britain that allow changes in precipitation to be determined.[33] Key periods of increased wetness are identified in northern Britain, with marked shifts to wetter conditions in the mid-4th and 8th centuries A.D. These compare to raised lake levels in the Alps between 150-250 cal. A.D. and 650-850 cal. A.D,[34] along with oxygen isotopes from *Sphagnum* cellulose from Walton Moss in northern England,[35] that show broadly the same trends. Whilst there is some correspondence with inferred rainfall in central Europe (Figure 1.E), there are apparent differences between trends in precipitation, particularly the mid-4th century 'wet shift' in Britain which appears to have begun at the start of the 4th century in central Europe, and during the mid-5th century A.D. when central Europe is becoming drier whilst northern Britain becomes wetter.

These northern British wet/dry periods superficially appear to correspond to the periods of warmer and cooler summer temperatures identified through oxygen isotopes from a speleothem (stalagmite) in South West Ireland (Figure 1.A),[36] and in Luterbacher *et al*.'s synthesis of a wide range of proxy records from across mainland Europe (Figure 1.B).[37] The picture that emerges in Britain is one of very gradual cooling during the Early Roman period when it was relatively wet compared to the rest of the first millennium A.D. The 4th century was cooler and drier, and while it now appears that this was a period of declining population in Britain,[38] it seems unlikely that there was a causal link: the decline in population was not synchronous across Britain, and the regions where the decline in population was most marked, such as the South East, were lowland areas where a small fall in temperatures will have had least impact through, for example, reducing the growing season. The impact of drier conditions is unclear: some crops may have had lower yields if they received less

[32] Buntgen *et al*. (2016), 231
[33] Charman *et al*. (2006)
[34] Magny (2004)
[35] Daley *et al*. (2010)
[36] McDermott *et al*. (2001)
[37] Luterbacher *et al*. (2016)
[38] Smith *et al*. (2016)

moisture during critical growing periods, but conversely heavy clay soils will have suffered less waterlogging and there may have been less need for drying corn following the harvest.

Büntgen *et al*. have linked the migration period to temperature and precipitation changes between the 4th and 6th century[39], but it is clear that these climatic changes, and the pronounced deterioration that has been widely recognised appear to have started with the eruption of an unidentified volcano in A.D. 536, had no discernible impact in Britain as temperatures and probably precipitation were stable from the start of the 6th century. It is noticeable, however, that the period of economic expansion during the ‘long 8th century’ did correspond to a period of warmer and wetter conditions, although the relationship between the two is unclear. This period also saw the emergence of stable kingship, a revival in international trade, and the replacement of folk territories (and their strongly communal patterns of agriculture) with estates owned by the King, the newly re-established Christian church, and an emerging secular aristocracy: it is difficult to see how these will have been caused by gradual, and slight, changes in climate.

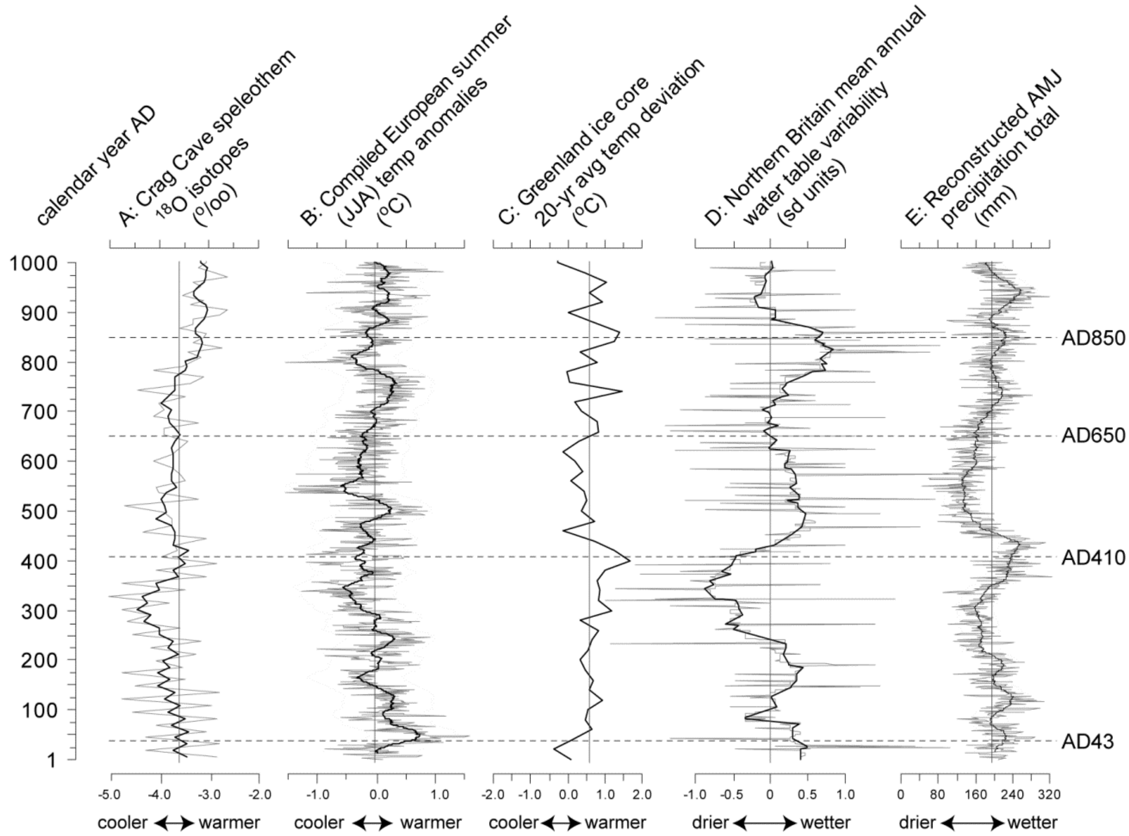

Figure 1: Compiled palaeoclimatic proxies for the first millennium A.D. The Crag Cave speleothem indicates palaeo-temperature, while the Northern Britain water table variability is a palaeo-precipitation record. Values for the compiled European summer temperature and Greenland ice core record are expressed as anomalies from the twentieth century average. Vertical lines indicate the first millennium A.D. average (Sources: A: McDermott et al. *2001; B: Luterbacher* et al. *2016; C: Vinther* et al.*, 2009; D: Charman* et al.*, 2006; E: Büntgen* et al. *2011) (drawn by Ralph Fyfe).*

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[39] Büntgen *et al*. (2011)

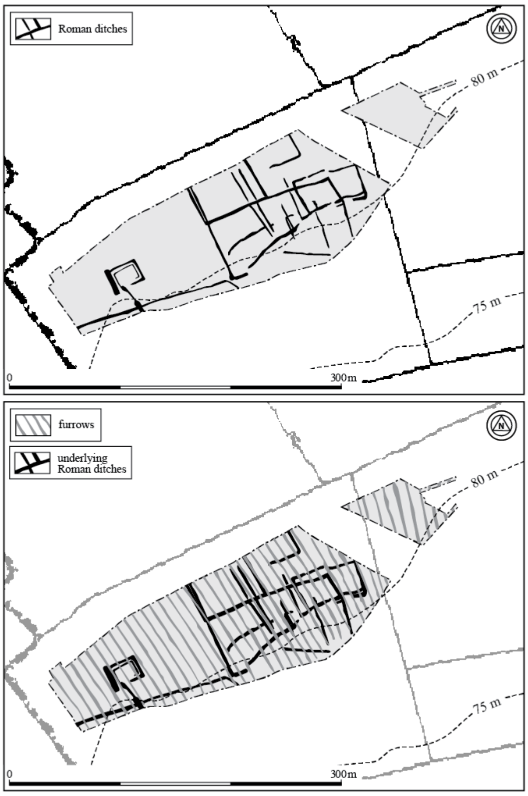

Figure 2: The excavations at Weedon Hill, in Aylesbury (Buckinghamshire). Extensive excavations revealed a Romano-British enclosure complex on the same orientation as the overlying ridge and furrow, and the historic landscape (after Wakeham 2007; OS 1st Edition Six Inch base map: © Crown Copyright and Landmark Information Group Limited (2013), all rights reserved, 1884; drawn by Chris Smart).

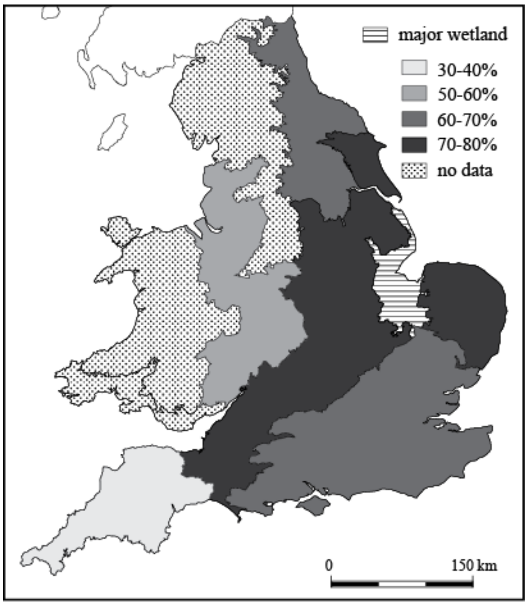

Figure 3: the extent to which excavated Romano-British field boundaries across Roman Britain share the same orientation and/or alignment as historic landscapes characterized by former medieval open fields and closes (drawn by Chris Smart).

THE ARCHAEOLOGICAL DATA

The extent of potential continuity within the landscape of Britain during the 1st millennium A.D. was explored in *The Fields of Britannia*, one of a number of 'big data' projects that are attempting to synthesize the vast amount of often unpublished data from recent development-led archaeology in Britain.[40] One strand of research was to investigate the relationship between excavated Late Roman field systems and the medieval boundaries that overlie them (e.g., Figure 2). Across lowland areas that in the medieval period had either open fields or closes held in severalty,[41] 64% of excavated Late Roman field systems share the same orientation as medieval boundaries,[42] although this overall figure hides marked regional variation with the greatest degree of correspondence in England's 'Central Zone' and East Anglia (Figure 3).

These figures are not in themselves proof of continuity: fields may have seen a change in land use, for example from arable to pasture, but any periods of abandonment are likely to have been very brief such that woodland did not fully regenerate across the fields. Grazing animals are required to maintain open ground, with sufficient stocking densities to remove all regenerating sapling foliage,[43] and long-term field observations at the Rothamsted Experimental Station, in Hertfordshire, have shown that without grazing woodland regeneration on former arable fields will occur within 10 to 30 years.[44] The analysis of historic maps, such as sequential revised editions of the Ordnance Survey Six Inch series, reveals a similar picture with former agricultural fields being invaded by scrub and regenerated woodland within 20 to 30 years.[45] Some may argue that a field system could have been abandoned, covered in woodland, and then restored following the clearance of that woodland, although this is very unlikely: the felling of trees, dragging away the logs, and the grubbing out of tree stumps is a very destructive process that will destroy the relatively fragile remains of long abandoned field boundaries. It may also be argued that even if an earlier field system was lost due to woodland regeneration, following the clearance of woodland a new field system would be laid out on the same orientation because both sets of boundaries would have followed the contours: this may have happened in some cases, but it is difficult to see how it can account for 64% of field systems as so many of them lie on areas of flat ground (particularly in the claylands that cover so much of central and eastern England).

The Fields of Britannia project also examined animal bone and charred cereal assemblages from the Roman and medieval periods.[46] These show that over the course of the Roman period there was an increasingly market-driven pattern of agriculture, with a growing focus on raising cattle and growing wheat. At the start of the early medieval period this was reversed with the re-emergence of greater local variation in animal husbandry and cropping regimes as seen before the development of the Roman market economy. Crucially, farming did not stop in the 5th century, but simply changed to a less intensive and more subsistence based form.

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[40] e.g. Smith *et al*. (2016); Blair (forthcoming); Gosden (2013) with final publication in due course.
[41] Fields that instead of being shared between a series of land-owners or tenants were wholly with the occupancy of one farmer
[42] Rippon *et al*. (2015), tab. 3.7
[43] Pollock *et al*. (2005)
[44] Harmer *et al*. (2001)
[45] Rippon (2012) 7
[46] Rippon *et al*. (2014); (2015), 74-85

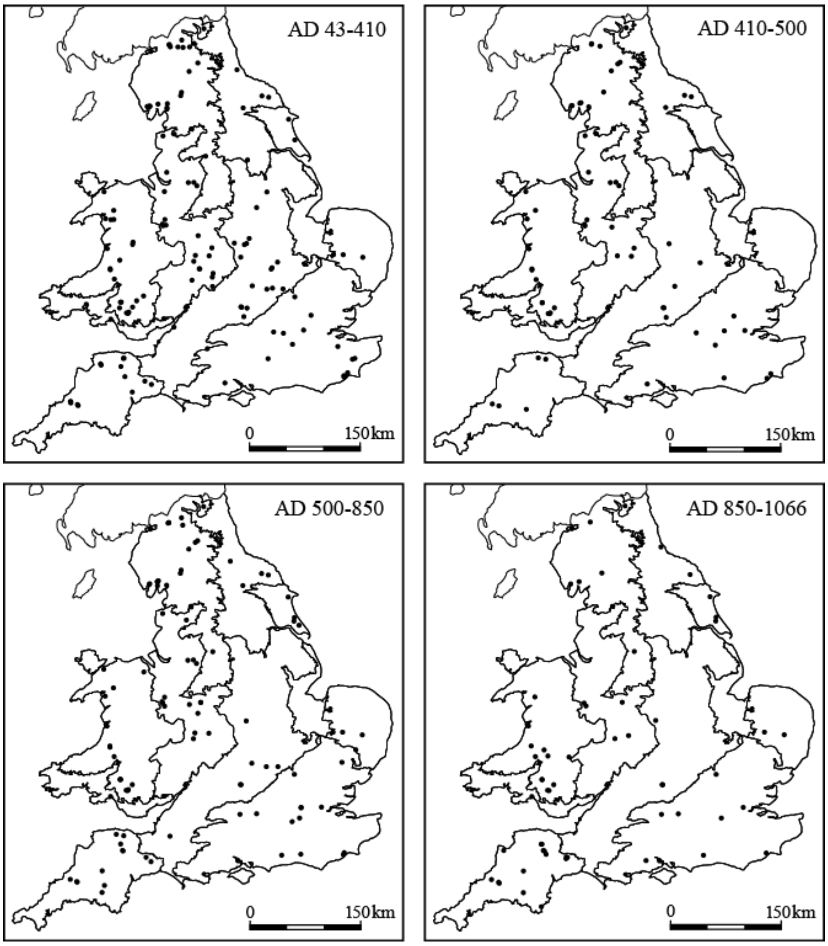

Figure 4: the distribution of pollen sites used in this study (source: Rippon et al*. 2015, fig. 3.2, drawn by Chris Smart).*

THE PALYNOLOGICAL DATA

In order to explore whether or not there was an extensive woodland regeneration in the post-Roman period we can turn to the palynological evidence. A search through the published and unpublished 'grey literature' has revealed that up to 2013 there were 194 pollen sequences dated to the Roman and/or early medieval periods in Britain south of Hadrian's Wall and its immediate environs (Figure 4).[47] In contrast to Dark's review published in 2000 there are now both a considerably larger number of sequences, and far more examples from lowland areas. This figure of 194 includes long 'off-site' sequences taken from natural deposits such as peat bogs (that are usually radiocarbon dated), and shorter 'on-site' sequences usually from settlement-related features such as pits, ditches and wells (which are dated through radiocarbon determinations or artefactual evidence). This increased number of lowland pollen sites has helped to overcome a major problem with earlier syntheses, namely that most 'off-site' pollen work was undertaken in areas beyond those that were settled during the Roman and medieval periods, such as uplands and wetlands. These 'traditional' pollen sites at best give a very general regional picture, and will always undervalue the significance of arable cultivation. The increasing numbers of pollen sequences from lowland areas have the great advantage of being closer to areas of the landscape that were settled and farmed in the 1st millennium A.D., although they can suffer the disadvantage of only reflecting land use in very localized areas. Within the context of research projects this problem can be overcome by sampling several locations within an area,[48]

[47] Rippon *et al*. (2015) 58
[48] e.g., Rippon *et al*. 2006

although a lack of suitable deposits – or in the case of commercial work, the limited opportunities afforded by the development window – means that in many cases the only sequence that is available comes from a single location. One way around the local differences that such sequences will reflect is to group data which can be carried out at two scales: local districts – or '*pays*'[49] – that had a coherent natural and cultural landscape character, and broader regions that while geologically diverse were culturally coherent. Britain can be divided into nine such regions (Figures 3 and 4):

- South East: a highly Romanized region reflected in a well-developed urban hierarchy and large numbers of villas, although there was a marked decline in settlement during the 4th century across eastern areas; evidence for Anglo-Saxon immigration found in some but not all districts; very little settlement nucleation and open field.
- East Anglia: a moderately Romanized region reflected in a poorly-developed urban hierarchy and relatively few villas; extensive evidence for Anglo-Saxon immigration found in most districts; some settlement nucleation and open field from the 'long 8th century' onwards.
- Central Zone: a highly Romanized region reflected in a well-developed urban hierarchy and large numbers of villas, and prosperity maintained well into the 4th century; evidence for Anglo-Saxon immigration found in some but not all districts; extensive settlement nucleation and open fields from the 'long 8th century' onwards.
- South West: a poorly Romanized region reflected in there being just a single town and very few villas; no Anglo-Saxon immigration; limited settlement nucleation and open field development from the 'long 8th century' onwards.
- Lowland Wales: a moderately Romanized region reflected in a poorly-developed urban hierarchy and relatively few villas; no evidence for Anglo-Saxon immigration; some settlement nucleation and open field from the late 11th century onwards.
- Western Lowlands: a poorly Romanized region reflected in a poorly developed urban hierarchy and very few villas; no Anglo-Saxon immigration; very limited settlement nucleation and open field development.
- North East Lowlands: a poorly Romanized region reflected in a poorly developed urban hierarchy and few villas; extensive Anglo-Saxon immigration; possible settlement nucleation and open field development from the 'long 8th century' onwards, and extensive re-organisation of landscapes following the 'Harrying of the North' in the late 11th and 12th centuries.
- Northern Uplands: the sparsely settled uplands of northern England.
- Upland Wales: the sparsely settled uplands of Wales.

These regions were defined on the basis of their coherent cultural history and contain considerable geological diversity, but unfortunately many of the discrete *pays* within them have few or no pollen sequences (notably the chalk downland and limestone hills). What is presented here is, therefore, the first attempt at regional scale analysis which it is hoped will inspire finer-grained work in the future.

For the purposes of the analysis presented here data from pollen sequences were divided into four periods: A.D. 43-410 (Roman), A.D. 410-500 (the Anglo-Saxon migrations), A.D. 500-850 (broadly the period of recovery from the collapse of the Roman economy), and A.D. 850-1066 (the Viking disruption and recovery thereafter). It should be stressed that throughout this period, radiocarbon dating is nowhere near as precise as archaeological or historical chronologies, and although the 5th century is crucial to our understanding of what happened to the landscape following the Roman period, unfortunately there are relatively few pollen assemblages that have been dated specifically to that period (and none in the whole of East Anglia). In part this problem is caused by the

[49] e.g., Brown *et al*. (2014)

wide sampling intervals used in most pollen diagrams which means that crucial – but chronologically short – events such as the collapse of the Roman economy in the 5th century, the Viking incursions of the 9th century, and the Norman invasion and Harrying of the North in the 11th century, will only show up in pollen diagrams if they had a lasting effect. A second challenge is establishing chronologies for pollen sequences where these are based on radiocarbon dating as the nature of process of calibrating radiocarbon dates to calendar years can result in significant uncertainties, particularly given a series of short 'plateaux' in the calibration curve in the 1st millennium A.D. This means that whilst pollen samples can be assigned a 'best' age (based on an age-depth curve) there may be up to a hundred years uncertainty in this.

Based upon online data bases (Royal Horticultural Society, and Royal Botanic Garden) cross-referenced with *The Hillier Manual of Trees and Shrubs*,[50] in the analysis that follows pollen taxon are grouped into those indicative of four broad vegetation types: woodland (all forms, including wet woodland in valley bottoms), arable (cereals and arable-indicative weeds), improved pasture, and unimproved pasture.[51] Percentages refer to the pollen from those land-use groups as a proportion of Total Land Pollen, and it must be stressed that as some plants – particularly wind-pollinated trees – produce far more pollen than others[52] these figures do not directly relate to the proportion of the landscape that was subject to that type of land use (i.e. if 40% of the pollen from a particular region was indicative of woodland, this does not mean that 40% of the land mass of that region was forested). A further compounding factor is that pollen data are expressed in the 'closed world' of proportions. This means that changes in the abundance of one taxon within the landscape will have a 'knock-on' effect on the proportions of all others. Fyfe demonstrated that changes in the character of open-ground taxa (e.g., from a low pollen-producing grassland to a high pollen-producing heathland) can have a significant impact on the (proportional) representation of woodland pollen, even when the spatial extent of that woodland did not change.[53] This is more likely to impact on 'local' pollen signals than regional ones that homogenise pollen from a wider area, and so should not be a major problem with the data for lowland Britain presented here. In spite of these confounding issues, using pollen percentage data for a landscape such as Britain's that was already extensively cleared of woodland by the eve of the Roman Conquest, we can therefore at least compare the relative significance of land-use types in different regions, as one with 40% tree pollen will be more wooded than one with 20% tree pollen (even though we cannot say that it was twice as wooded).

[50] Hillier and Coombes (2007) esp. 493-8

[51] Rippon *et al*. (2015) Appendix II

[52] Brostrom *et al*. (2008)

[53] Fyfe (2006)

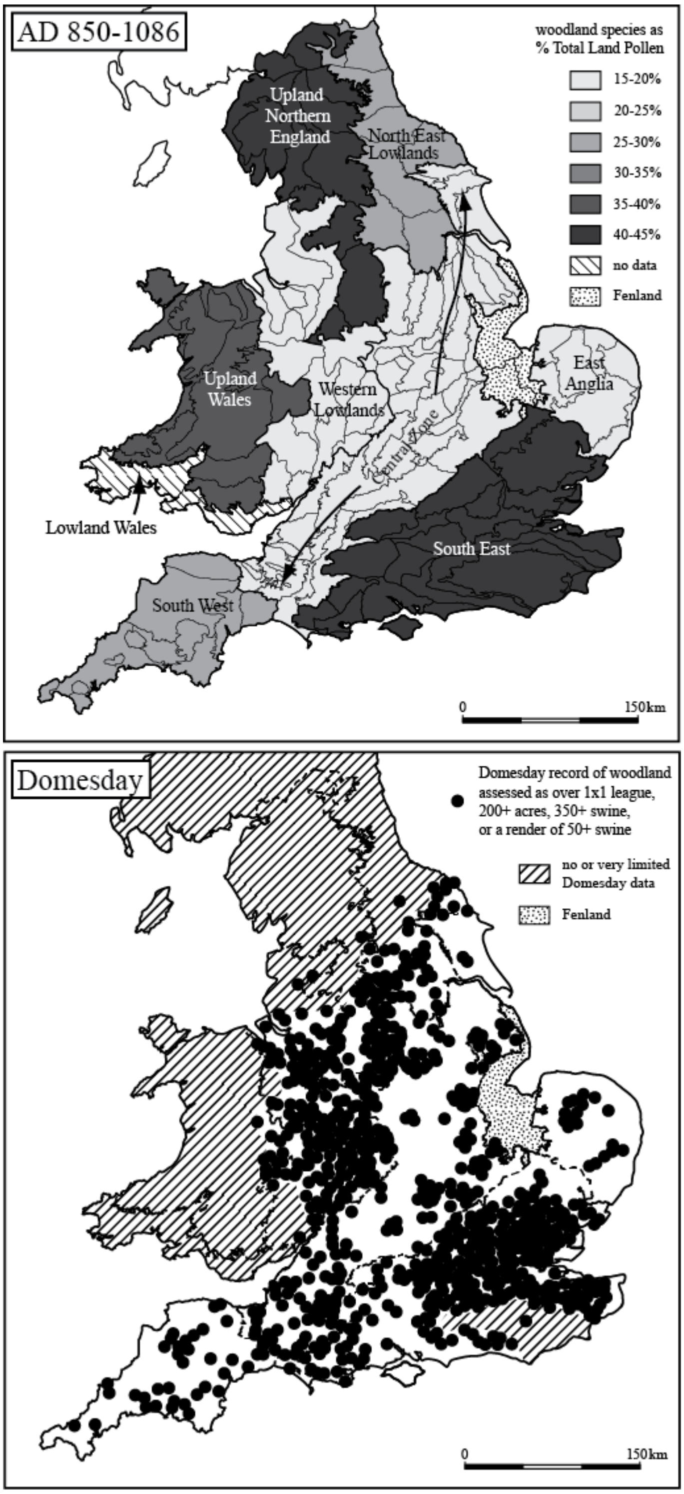

Figure 5: the correlation between woodland-indicative pollen, and larger woodlands recorded in Domesday (assessed as over 1x1 league, 200+ acres, or 350+ swine (source: Rippon et al. *2015 and Darby 1977, fig. 64; drawn by Chris Smart and Stephen Rippon).*

For the late first millennium it is possible to calibrate the pollen record with a fairly comprehensive documentary source – the Domesday Book – which covers most of England (although not the far north: Figure 5). This shows a good, but not perfect correlation between Domesday references to woodland and areas with relatively high percentages of tree pollen, with parts of the South East appearing the most wooded region in both data sets, in contrast to East Anglia and the Central Zone that were the least wooded overall in both data sets. The anomaly is the lowlands of the West Midlands that appear well-wooded in Domesday, but for which the pollen records suggest were extensively cleared. This could be accounted for by woodland being more comprehensively recorded in this region compared to elsewhere (regional inconsistencies within Domesday are well known[54]), or that the pollen sequences in this particular region are not very representative (for example there not being any from the Forest of Dean; Figure 4).

An alternative approach to the interpretation of pollen data has been developed over the last decade which involves the application of model-based 'correction' of pollen data to quantified vegetation abundance, in particular the REVEALS approach for quantification of regional vegetation cover.[55] This method relies on a more thorough understanding of the pollen-vegetation relationship, and has been applied to data from the UK to produce the first estimates of different plant abundances at the regional scale.[56] The results provide greatly improved understanding of vegetation cover, but at present the method is limited in three ways. Firstly it requires raw pollen count data and thus cannot be applied to published diagrams where these data are not available. It is not therefore possible to use all 194 sequences that are otherwise reviewed here and in fact only 35 sets of pollen data can be used. This is a clear limitation, particularly as those sequences with raw pollen count data are mostly in physically marginal areas that are not typical of lowland Britain. Secondly, in order to apply the REVEALS approach count data is also typically aggregated into long time windows (e.g., 500 years) to reduce uncertainty in correlation between sequences, which has the disadvantage of cutting across key periods of landscape change. Thirdly, the number of pollen taxa that can be transformed is currently limited to the major types, and does not include many arable weeds that are typically poorly represented in the pollen rain in a region.[57] Bearing these issues in mind, a comparison of Figures 6 and 7 highlights the over-representation of woodland in percentage pollen diagrams (e.g., compare the Western Lowlands and South West in Figure 6 with the North West and mid-North Devon/Dartmoor in Figure 7). As most sequences used in the REVEALS approach are, however, from areas peripheral to mainstream settlement and agriculture (e.g., areas of the Weald and the New Forest that were relatively well wooded, and the uplands of Dartmoor) there is also a significant over-representation of heathland (which would form part of the 'unimproved pasture' category in Figure 6) and under-representation of arable land use. Whilst much research has demonstrated that the REVEALS approach provides an improved estimate of regional land use, the spatial coverage and volume of data available means that examination of the percentage TLP data is still the best approach for a comprehensive view of land use in lowland areas during the Late Roman and early medieval periods until more count data is made more readily available for analysis.

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54 Darby 1977
55 Sugita (2007)
56 Fyfe *et al*. (2013)
57 Brostrom *et al*. (2008)

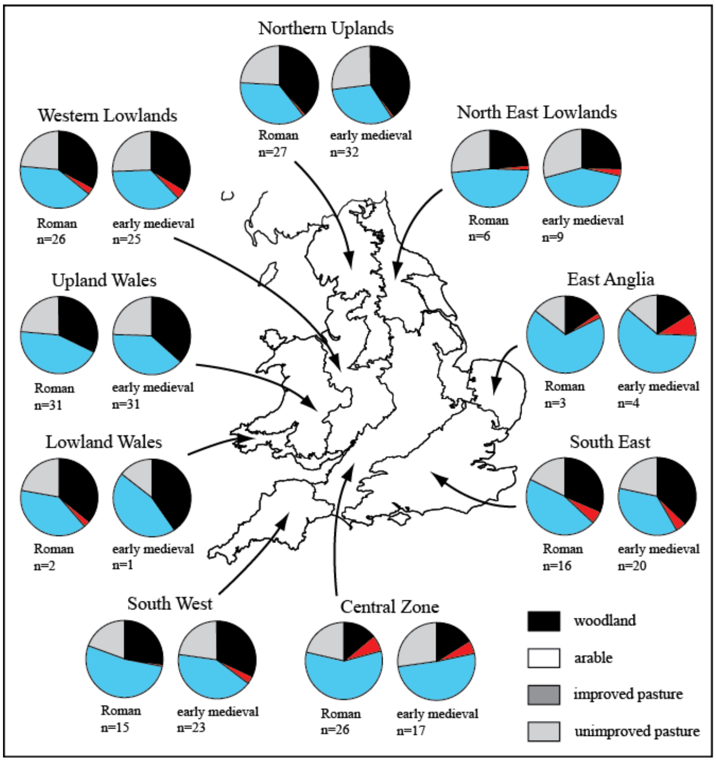

Figure 6: regional-scale variations in Romano-British and early medieval land use (source: Rippon et al. *2015, fig. 3.3; drawn by Chris Smart).*

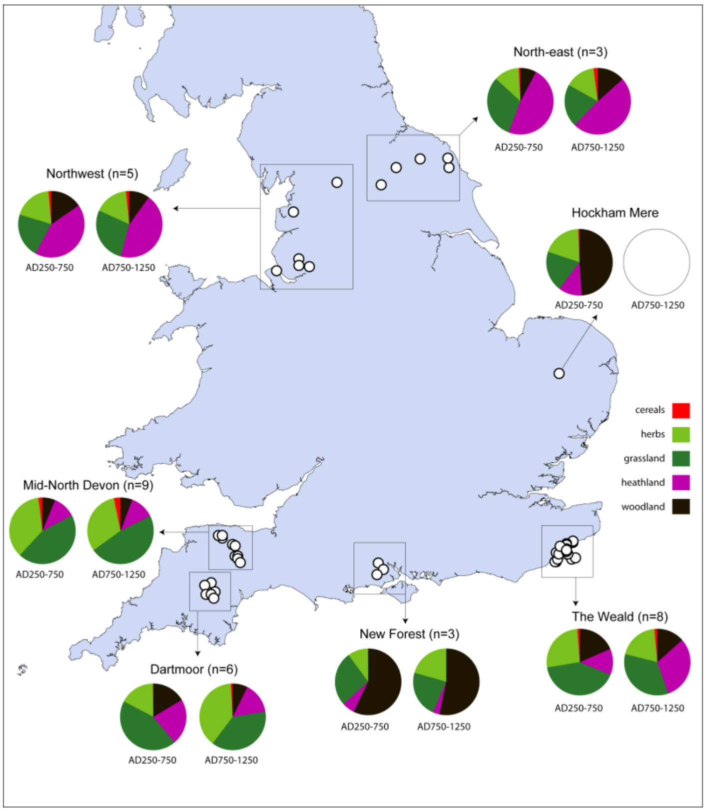

Figure 7: Quantitative estimates of relative vegetation abundance for the periods A.D. 250-750 and A.D. 750-1250 (based on Fyfe et al. *2013). No data is available for A.D. 750-1250 from East Anglia (drawn by Ralph Fyfe).*

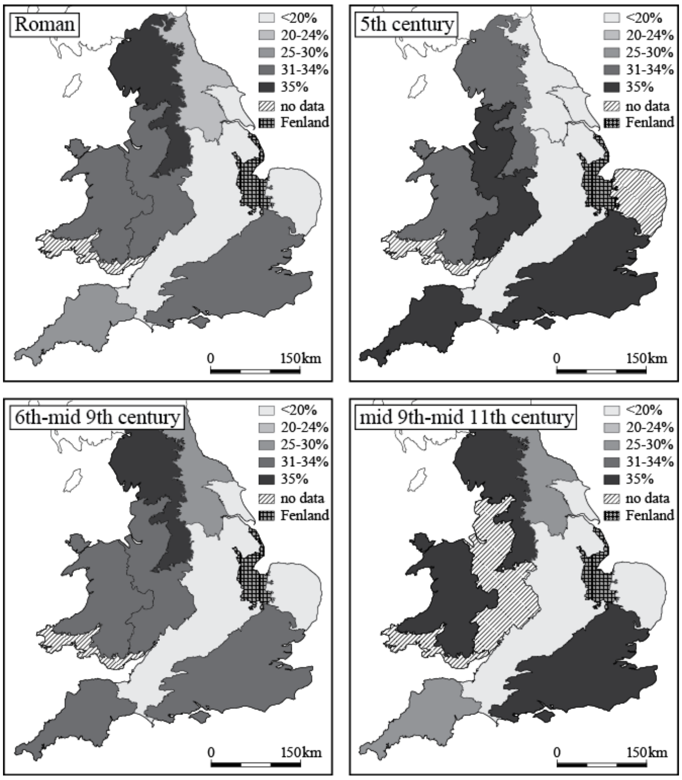

Figure 8: regional-scale variations in the proportions of tree pollen (sources: Rippon et al. *2015, tabs 4.2, 5.2, 6.2, 7.2, 8.2, 9.2, 10.2 and 11.2; drawn by Stephen Rippon).*

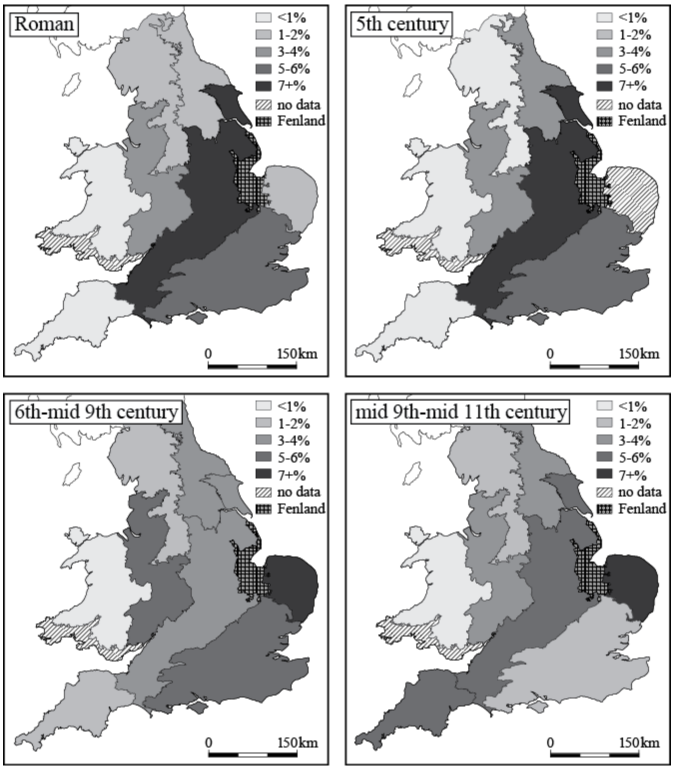

Figure 9: regional-scale variations in the proportions of arable pollen (sources: Rippon et al. *2015, tabs 4.2, 5.2, 6.2, 7.2, 8.2, 9.2, 10.2 and 11.2; drawn by Stephen Rippon).*

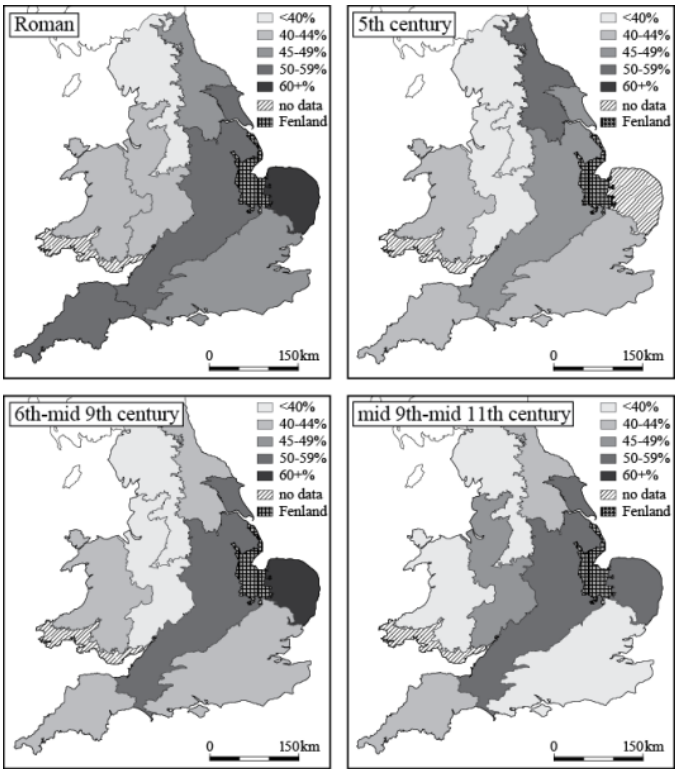

Figure 10: regional-scale variations in the proportions of improved pasture pollen (sources: Rippon et al. *2015, tabs 4.2, 5.2, 6.2, 7.2, 8.2, 9.2, 10.2 and 11.2; drawn by Stephen Rippon).*

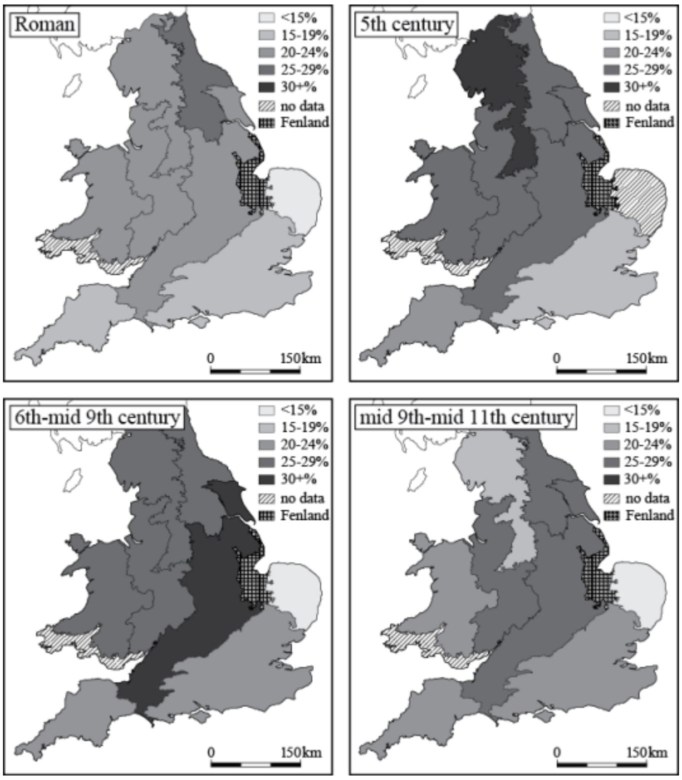

Figure 11: regional-scale variations in the proportions of unimproved pasture pollen (sources: Rippon et al. *2015, tabs 4.2, 5.2, 6.2, 7.2, 8.2, 9.2, 10.2 and 11.2; drawn by Stephen Rippon).*

The regional picture

Regional-scale variations in Roman and early medieval land use are shown in Figure 6, while Figures 8-11 map each of the four land-use types for the Roman period and three sub-divisions of the early medieval period.[58] During the Roman period, the most extensively cleared regions were East Anglia and the Central Zone where woodland-indicative pollen was just 16% of T.L.P. (Rippon *et al*. 2015, tab. 3.1: in averaging figures for *pays*, regions, and uplands/lowlands the individual figures from each pollen sequence were averaged, rather than averaging averages[59]). The South East (31% T.L.P.) and Western Lowlands (33% T.L.P.) were the most wooded, although it is worth re-emphasising that these pollen proportions do not directly equate to woodland cover and that woodland is over-represented, although by how much is unclear. As an example, 27% TLP in the South West equates to around 7% woodland cover after model-based correction using the REVEALS approach (Figures 6-7), although as the REVEALS data is all from upland areas which we expect to have been more extensively wooded, the surrounding lowlands will have been even less wooded.

In the 5th century there is clear evidence for a decline in the intensity of land use, but not for the widespread abandonment of agricultural land. In the Central Zone, for example, improved pasture pollen fell from 58% to 49%, and unimproved pasture increased from 21% to 27%, but tree pollen only increased from 15% to 16%.[60] Unfortunately there is no securely dated 5th century pollen diagram from East Anglia, although by the 6th to mid-9th centuries there had been no change in the amount of woodland pollen (16%). In the South East as a whole, in contrast, tree pollen increased from 31% to 39%, which was largely at the expense of improved pasture that fell from 45% to 40% (although across this geologically diverse region the expansion of tree pollen may have been concentrated in only some *pays* such as the heavy claylands north of London[61]). While this may indicate some woodland regeneration across former agricultural land, it cannot have been very great as this region – like the rest of lowland Britain – also saw the extensive survival of Romano-British field systems (Figure 3). Overall, these data shows that there was no single, simple land-use history across the whole of lowland Britain, with marked regional variations. It is striking, for example, that England’s ‘Central Zone’ – that sees the greatest potential continuity between Romano-British and medieval field systems (Figure 3) and the development of villages and open fields – was also the region that by the Roman period was most extensively cleared of woodland and had the greatest amount of arable cultivation (Figures 8 and 9).[62] There is also no correlation between these indicators of where the greatest landscape continuity may have been and those regions that saw the great Anglo-Saxon immigration.

[58] See Rippon *et al*. (2015) for a detailed discussion

[59] Rippon *et al*. (2015), 58.

[60] This is a good example of the confounding nature of working with pollen percentages. If 'unimproved pasture' pollen taxa are high pollen producers (e.g. heathers, which produce around four times as much pollen as the equivalent area of grass) then in absolute terms a change to 'unimproved pasture' will result in an absolute increase in pollen production. As pollen data are usually displayed as a percentage of all pollen, we might expect woodland pollen percentages to fall if levels of woodland remain the same. In a case such as this, i.e. woodland percentages remaining stable, an increase in woodland cover is implied.

[61] Bryant *et al*. (2005)

[62] This supports a hypothesis first put forward by Roberts and Wrathmell (2000; 2002) based upon a reconstruction of the extent of early medieval woodland using place-name and Domesday Book evidence.

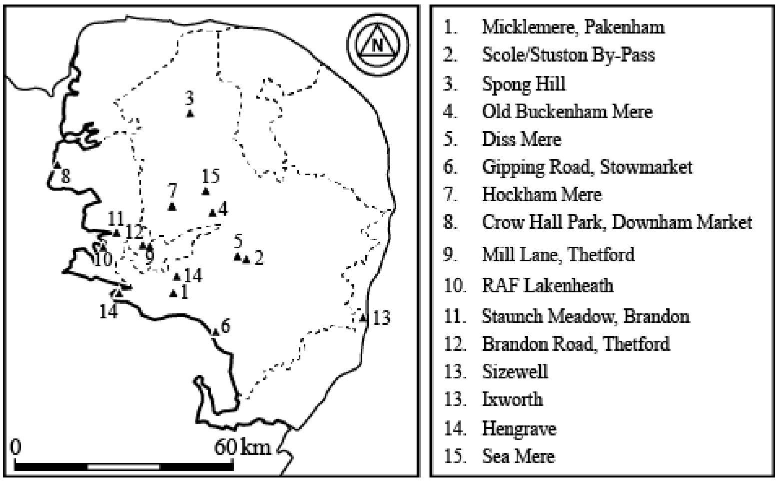

Figure 12: East Anglian case study area: places referred to the text (drawn by Chris Smart and Stephen Rippon).

A regional case study: East Anglia

In addition to some pioneering studies that are unfortunately poorly dated, East Anglia now has a series of well-dated pollen sequences (including some published since *The Fields of Britannia*, which are described below: Figure 12),[63]and it provides a good example of how the 'long 8th century' appears to have been more significant as a period of land-use change than when Britain ceased to be part of the Roman empire. The region is one of largely flat claylands, with some extensive areas of sand. The well-dated pollen sequence from a palaeochannel of the river Waveney at Scole, for example, suggests broad continuity in land use, including cereal cultivation, from the Late Iron Age, throughout the Roman period, and into the early medieval period, with no change in the extent of woodland or scrub in the post-Roman period (there may even have been an increase in arable and the intensity of grazing in the 5th century).[64] Around the 8th century (based on a calibrated radiocarbon date of A.D. 670–820) there was a period of agricultural intensification, with an increase in cereal pollen and the appearance of viticulture, while *Cannabis*-type pollen suggests the cultivation of hemp (or perhaps hops), which was also seen at Diss and Old Buckenham (see below). At Staunch Meadow in Brandon, in the Little Ouse Valley, there was similarly broad continuity from the Late Iron Age through to the early medieval period, although there may have been an intensification in arable during the Roman period including the cultivation of hemp, as well as an intensification in grazing. Around the 8th century a large amount of sand was blown across the landscape which may have been associated with changes in agricultural practices as it was associated with a decline in trees and pasture and increase in cereal and *Cannabis*-type pollen.[65] At Micklemere there was a marked increase in cereal pollen around the 8th century (dated 1290±100 BP, cal. A.D. 588–972) at the same time as an influx of mineral sediment, implying increased soil erosion in the catchment.[66] At nearby Ixworth, in the Blackbourn valley, a similar alluviation was seen in the Roman period although unfortunately this sequence does not extend into the early medieval period.[67] At Sizewell, on the east coast, the cessation of peat accumulation and onset of sand deposition is dated to shortly after

[63] Gearey *et al*. 2016
[64] Wiltshire (2014a) 418
[65] Wiltshire (2014b) 333
[66] Murphy (1996, 29)
[67] Gearey *et al*. (2016) 37

1505±30BP (cal. A.D. 440-630).[68] The onset of a rise in tree pollen at Hengrave, in the Lark Valley, is unfortunately not dated although it declined from around 1450±30BP (cal. A.D. 570-635).[69]

It is possible that other pollen sequences from East Anglia that show a period of agricultural intensification sometime in the early medieval period also date to this 'long 8th century', although in these cases dating is based upon interpolation from earlier radiocarbon dates or simply conjecture (although sections that were suggested as reflecting the Roman period are very similar to the well-dated sequence at Scole).[70] At Old Buckenham Mere there is a decline in oak woodland at a suggested date of '*ca*. A.D. 800',[71] while at Diss Mere, Old Buckenham Mere, and Sea Mere there is a marked increase in cereal pollen (including rye) and *Cannabis* type (hemp) at a suggested date of the 6th century.[72] At Hockham Mere a similar expansion in cultivation is dated to around the 9th century.[73] Overall, the archaeological data suggests East Anglia was a region with a relatively high correspondence between excavated Romano-British and medieval field systems, while pollen indicates that there were no profound changes in land use during the 5th and 6th centuries – when there was extensive Anglo-Saxon settlement – and that a more significant shift came during the 'long 8th century'.

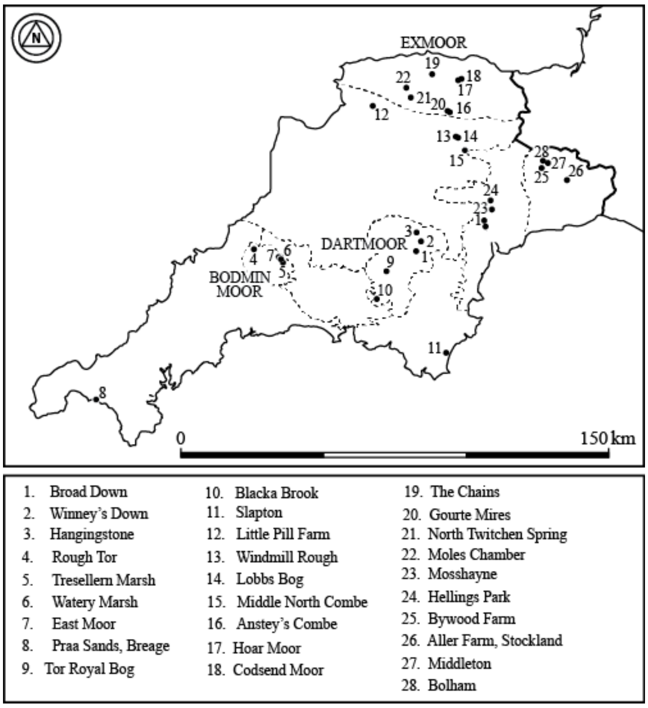

Figure 13 South West case study area: places referred to the text (drawn by Chris Smart and Stephen Rippon).

A regional case-study: South West Britain

The South West has also benefited from new palynological work since *The Fields of Britannia* Project (Figure 13).[74] It presents a contrasting case study to East Anglia as the South West does not demonstrate the same degree of Romanization as other parts of lowland Britain, and it lay beyond the main zone of Anglo-Saxon influence, and as such it might be expected to have had a different land-

68 Gearey *et al*. (2016) 74
69 Gearey *et al*. (2016) 30
70 Wiltshire (2014b) 413
71 Godwin (1968) 102
72 Peglar *et al*. (1989); Godwin (1968); Sims (1978)
73 Sims (1978) 57; K. Bennett (1983a, b)
74 e.g, Fyfe and Woodbridge (2012), Brown *et al*. (2014), and Perez *et al*. (2015)

use history through the first millennium A.D. preserving the remnants of a late prehistoric pattern. It is a highly diverse landscape, with granite (e.g., Bodmin, Dartmoor) and shale (Exmoor) uplands, and lowlands characterised by rolling topography. Pollen evidence indicates that the South West was extensively cleared of woodland in the Romano-British period, but shows less evidence of arable agriculture than other lowland areas (Figures 8-9).

The uplands have been the focus of most palynological research. On Bodmin Moor, the landscape at Rough Tor North was characterised by well-managed grassland with some heathland during the Romano-British period, while at Rough Tor South small increases in trees and shrubs occur during the latter part of the Romano-British period, although the dating has significant uncertainties.[75] During the 5th to 7th centuries Bodmin Moor remained an open landscape, with some evidence for small-scale cereal cultivation on East Moor and Watery Marsh.[76] A similar trajectory is described from comparable locations on the high moors of Dartmoor. At Blackabrook the landscape was largely open by the mid-1st millennium A.D. with an increase in grassland and some arable cultivation perhaps around the 8th century A.D., although the dating is not precise.[77] On Exmoor a series of pollen diagrams from similar elevations (i.e. below 350 m above sea level) describe a remarkably stable and open landscape of well-managed grazing throughout the Romano-British period and into the early medieval.[78] At The Chains, one of the highest parts of Exmoor and above 450 m above sea level, regeneration of scrub may indicate some reduction in intensity of land use in this more marginal area around 430-650 cal. A.D.[79] This pattern is not replicated in lower-lying sequences, however, and at North Twitchen Spring grassland expanded around 560-660 cal A.D.[80]A key change around the lowland fringes of Exmoor occurs around the 9th to 10th centuries with an expansion of arable cultivation at Anstey's Combe[81] and Gourte Mires.[82]

High Dartmoor, above the 400 m contour and beyond the settlement zone, presents a contrasting pattern to the lower moors. During the Late Iron Age there was a major expansion of improved and managed grassland at the expense of scrubby hazel woodland at Broad Down,[83] Winney's Down[84] and Hanginstone Hill.[85] Sometime during the late 3rd to 5th centuries A.D., however, there was a marked and significant period of woodland regeneration at Broad Down[86] and Winney's Down.[87] It is possible that this relates to a reduction in exploitation of metal ores,[88] although the timings for vegetation changes do not fit well with the geochemical evidence for deposition of the atmospheric pollutants. The woodland regeneration may instead reflect a reduction in the intensity of grazing on the high moors, similar to the more subtle regeneration on The Chains on Exmoor already described, which may have been related to a reduction in demand for food as the Roman market-based economy and urban populations disappeared.

[75] cal. A.D. 180-550, 1675±70, OxA-6007: Gearey *et al*. (2000)
[76] cal. A.D. 470-670, 1440±50, GU-5613: Gearey *et al*. (2000)
[77] Smith *et al*. (1981)
[78] e.g., Hoar Moor (Francis and Slater 1990); Codsend Moor (Francis and Slater 1992); Gourte Mires and Anstey's Combe (Fyfe *et al*., 2003); North Twitchen Spring and Moles Chamber (Fyfe 2012)
[79] 1500±60, UB-816 (Merryfield and Moore 1974)
[80] 1430±40, BETA-202087 (Fyfe 2012)
[81] 690-1010 cal. A.D. (1160±70, Wk-10612): Fyfe *et al*. (2003)
[82] 890-1160 cal. A.D. (1020±60, Wk-10619): Fyfe *et al*. (2003)
[83] 170-50 cal. B.C. (2090±20, UBA-14190): Fyfe and Woodbridge (2012)
[84] 360-110 cal. B.C. (2163±25, UBA-17175): Fyfe and Woodbridge (2012)
[85] hortly before 20 cal. B.C. – 120 cal. A.D. (1956±20, UBA-14214): Fyfe and Woodbridge (2012)
[86] 430-540 cal. A.D. (1582±20, UBA-14189)
[87] shortly after 230-380 cal A.D. (1748±24, UBA-17174)
[88] Meharg *et al*. (2012)

Pollen sequences from lower-lying locations are rarer in the South West. In the east, around the Blackdown Hills, Bywood shows a mixture of improved and unimproved pasture with some limited arable, in a landscape that still retained a reasonable amount of woodland.[89] At nearby Aller Farm there is evidence for the persistence of wet woodland around 90-380 cal. A.D..[90] The wet woodland was not cleared until around 410-770 cal. A.D. (1450±90, GU-2709), making way for managed pasture, and later, arable cultivation, although the start of cultivation is not securely dated. Clearance at Middleton and Bywood is dated to between the 6th and 8th centuries, with woodland replaced by improved pasture and heathland and there is little evidence for much arable cultivation around these sites.[91] To the west, a series of sites in mid-Devon (Lobbs Bog, Windmill Rough, and Middle North Combe)[92] demonstrate a largely open, pastoral, landscape from the start of the first millennium A.D., with most woodland clearance completed in late prehistory. There is very little evidence for any changes in the character of vegetation or land use from the Late Iron Age through to the post-Roman period. During the 7th-8th century A.D., however, these sites show marked and consistent changes: a dramatic increase in cereals, a continued strong pastoral element suggesting good quality grazing, and an increase in rough grazing on the more marginal areas:[93] this may reflect the emergence of a new form of cultivation in the region known as convertible husbandry.[94] In North Devon (at Little Pill Farm)[95] and South Devon (at Slapton)[96] the Roman and medieval landscape was open, showing predominantly improved grassland. Environmental evidence from further west, in lowland mainland Cornwall, is extremely sparse for the Romano-British and early medieval periods, and only Praa Sands has a sequence that extends through the first millennium A.D. which shows a predominantly open, pastoral landscape throughout.[97]

Overall, the South West shows a strong degree of continuity in land use from the late prehistoric through to the Roman and start of the early medieval periods. It is not surprising that a relatively un-Romanized region saw little significant change in land use after Britain ceased to be part of the Roman empire. As this region lay beyond those areas affected by the Anglo- Saxon migrations it was possible that this late prehistoric and Romano-British pattern of land use survived into the later medieval period but this was not the case as the South West saw a similar intensification of agriculture around the 8th century as seen elsewhere in lowland southern Britain.

CONCLUSIONS

This paper has explored the contribution that palynology has made to our understanding of landscape and society within Britain (south of Hadrian's Wall) during the 1st millennium A.D. Until recently there were relatively few pollen sequences that covered the Roman and early medieval periods, and those that had been published were mostly from physically marginal locations such as uplands which lay well away from parts of the landscape that were actually settled at that time. Although the situation is now improving, with more work being done in the lowlands, there is still a need for more research in these areas, and in particular more high resolution sampling and dating. Whilst at present the synthesis of pollen data must rely upon simple proportions of Total Land Pollen, as this is the

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89 Brown *et al*. (2014)
90 1790±50, GU-2708 (Hatton and Caseldine, 1991)
91 Brown *et al*. (2014)
92 Fyfe *et al*. (2004)
93 This happens at Lobbs Bog shortly before cal. A.D. 670-890 (1240±50 BP, Wk-11315), at Windmill Rough shortly after cal. A.D. 560-770 (1380±50 BP, Wk-11319) and at Middle North Combe before cal. A.D. 1010-1280 (900±80 BP, Wk-9469)
94 Rippon *et al*. (2006)
95 Barnett *et al*. (2007)
96 Foster *et al*. (2000)
97 French (1983)

form in which so much data is published, in the future corrections to this data through techniques such as REVEALS has huge potential for reconstructing how patterns of land-cover actually changed over time.

There is also a need for far greater dialogue between archaeologists, historians, palaeoenvironmentalists, and palaeoclimatologists so that the huge potential of scientific data can be realised by those writing cultural histories, and crude deterministic interpretations can be avoided when trying to interpret climate data. The archaeological, palynological, and palaeoclimate data presented here leads to three key conclusions. Firstly, there was very marked local and regional variation in land use across lowland Britain in the 1st millennium A.D., and we need further work on the landscape biographies of individual *pays* in order to explore the extent to which different communities responded to regional- and national-scale socio-economic changes in the context of the opportunities and restrictions that their natural environment offered. Secondly, the 'long 8th century' (the later 7th through to the early ninth centuries) appears to have seen far more profound changes in land use than the century following Britain's exit from the Roman empire. The 5th century did see a decrease in the intensity of agriculture, but there was no widespread abandonment of farmland and resulting woodland regeneration both in areas that did and did not see Anglo-Saxon immigration. Patterns of cereal cultivation and animal husbandry suggest that agriculture quickly reverted to the mixed regimes that characterized the pre- and Early-Roman periods, but most landscapes continued to be farmed.[98] Thirdly, while climate change may have provided a context for these changes in land uses in lowland areas, they were primarily caused by social factors not changes in rainfall and temperature.

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[98] Rippon *et al*. (2015), 74-85

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