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# From content to context: A food residue study of ceramics of the fourth millennium BC in the Upper and Middle Thames Valley, UK

by

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ABSTRACT

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# FROM CONTENT TO CONTEXT: A FOOD RESIDUE STUDY OF CERAMICS OF THE FOURTH MILLENNIUM BC IN THE UPPER AND MIDDLE THAMES VALLEY, UK

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This research explores the extent to which food residues from ceramics can contribute to archaeological understanding of the fourth millennium BC. Known archaeologically as the Early and Middle Neolithic, this prehistoric period is disputed among archaeologists and food-related evidence is especially contested. This research explores food-related evidence from new angles in that traditional approaches to diet are abandoned in favour of smaller-scale study of cookery practices. Food residues from Early and Middle Neolithic ceramic vessels were analysed by GC/MS and GC/C/IRMS. The techniques target the lipid (fats, oils, and waxes) component of foods that were cooked in the ceramic vessels in prehistory. The scientific datasets thus obtained were integrated with contextual information from the ceramic assemblages and the sites at which they were recovered. The sampled ceramic assemblages were recovered from archaeological sites made up primarily of pit features, which contain important evidence of life beyond the conspicuous monuments of the Neolithic. Several pit sites have come to light in the Upper and Middle Thames Valley during developer-funded excavation in the last couple of decades, and a new picture of everyday lives in the fourth millennium BC is emerging. This research contributes to this emerging picture in that it reveals local variation and regional consistency in foodways and pottery use. It demonstrates that pottery and food were closely connected during this period and that potters actively responded to the requirements of food preparation. This interplay between pottery and food has implications for more traditional typological studies of the ceramic record. It is argued that food residues from ceramics can be a source of information for material culture studies as well as for dietary reconstruction.

For Alastair Aitken (1972-2009)

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# Academic Thesis: Declaration of Authorship

I, **Emilie Sibbesson**, declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

**From content to context: A food residue study of ceramics of the fourth millennium BC in the Upper and Middle Thames Valley, UK**

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# Introduction

## Research context

The social significance of food is well recognised and has been eloquently articulated time and again. Mintz and Du Bois (2002: 102) state that '[n]ext to breathing, eating is perhaps the most essential of all human activities, and one with which much of social life is entwined'. Caplan (1997: 1) suggests that 'the study of food reveals our social and cultural selves, as well as our individual subjectivities'. Sometimes, it gets personal. Counihan (1999: 1) writes: '[m]y story with food runs deep. It runs through my childhood filled with physical activity and the consumption of enormous amounts of candy and sugar, a story I have yet to tell'. Food can be a source of anxiety and comfort – both privately and politically (e.g. Griffiths and Wallace 1998), and food creates and maintains a sense of belonging and of social exclusion (e.g. Jones 2007).

Archaeologists are paying attention. For example, Atalay and Hastorf (2006: 283) have studied food remains from Neolithic Çatalhöyük because '[p]erhaps more than any other human activity, food intensively creates the individual as well as the community through the daily practices of eating'. In the introduction to her edited volume on archaeologies of food and identity, Twiss (2007: 2) points out that food is 'an unusually powerful symbol of identity because foodways involve both the performance of culturally expressive behaviours and the literal incorporation of a material symbol'. The intimate links between our food and our bodies has also been explored by Hamilakis (1999: 39), who suggests that 'food consumption acquires such an immense significance and power in societies past and present because it involves […] the human body'. However, the body is not in focus here. Instead, I am interested in the objects that people in the past used when they prepared and ate food. These objects were involved in the transformations of raw ingredients into meals. We see the traces of these meals in the archaeological record in, for example, the skeletal make-up of the human consumer, the companionships forged through food sharing, and the residues and rubbish left behind.

Further engagement with these traces in the British Early and Middle Neolithic record is overdue. Today, in our corner of the world, most of us are far removed from the sources of our food. For the majority of the human past almost all members of a community would have been involved in some aspect of food procurement. In the Neolithic, activities related to animal husbandry, butchery, plant gathering, crop management, plant processing, and food storage preparation would have taken up a large part of the day, perhaps most days. However, foodways are an underexplored source of socially meaningful narratives for the British Neolithic. Whittle (2003: 30) points out that our understanding of eating in the Neolithic is a ‘sad reflection’ of the wealth of information from hearths, faunal remains, plants, and pottery. I would add that the information generated through the set of scientific techniques that target food remains has not necessarily enhanced our understanding of Neolithic foodways. Archaeological information generated in a laboratory tends to be interpreted in a processual framework. For food data from organic residues or stable isotopes, this means that output is discussed in terms of diet, subsistence, and economy. The primary data in this project comes from organic lipid residues from pottery, and the main question that I ask is whether this type of data from the Neolithic can be taken further than it usually is. This is an important question for two reasons: first, food residues from pottery do *not* address questions to do with diet or economy. Instead they relate to cookery practices and pottery use, which in light of the increased interest in social aspects of foodways should be of relevance to Neolithic archaeologies. Second, the question matters because Neolithic food evidence is continually pressed into service to support one of two dominant models of the origins and character of the period.

The British Neolithic begins around 4000 BC. The way in which it ‘began’ is unresolved, and discussion has in the last two to three decades centred on two main models. Namely, the new features that appear in the archaeological record around 4000 BC were put there either by recently transformed indigenous groups or by settlers from mainland Neolithic Europe. The Mesolithic-Neolithic transition is not central in this project. However, to some extent our understanding of the fourth millennium BC – the Early and Middle Neolithic – relies upon our view of the transition. Currently, more nuanced narratives that are capable of accommodating both insular changes and incoming groups are emerging. Focus has shifted away from the immediate ancestry of the protagonists to instead consider the impacts of their interaction. It is within such a framework that I situate this research. In my view, the decades of debate have proved not the validity of one model or the other, but the futility of the question itself. Crucially for this project, the longstanding debate on the Mesolithic-Neolithic transition and the character of the Neolithic period has influenced our engagement with food evidence.

## Research aims

The question that underpins this project is to do with the scope and relevance of food residues from ceramics. This question is explored within the context of the Early and Middle Neolithic because food evidence of the period is contested and our economic models too rigid. The project focuses on the Upper and Middle Thames Valley, an area in which many Neolithic sites have been encountered in developer-funded investigations in the last two decades. Prominent among the 'new' Neolithic remains are sites made up of pit features. These humble sites provide evidence about Neolithic lives beyond the monuments, but they have as yet been granted little scientific attention. In this project I address questions such as:

- How might we discuss Neolithic foodways beyond stagnated terms such as 'diet' or 'subsistence'?
- How were Early Neolithic bowls and Peterborough Ware pottery used?
- Can information about the ways in which pottery was used also tell us something about how it was made?
- What specific challenges does Neolithic pottery pose to the archaeologist looking for food residues, in terms of:
    - Its often fragmentary state of preservation?
    - The troublesome typologies of Early Neolithic bowls and Peterborough Ware?
- Can variation over time in cookery practices be discerned, for example from Early to Middle Neolithic?
- Can spatial variation in cookery practices be discerned?
- How might we contextualise food residue data beyond the ceramics themselves?

## Organisation

In Chapter 1 I discuss the polarised debate about the transition from the Mesolithic. A historical perspective on the subsistence categories that are at stake helps to untangle the expectations placed on food evidence of the fourth millennium BC. I outline the ways in which the study of food in the Neolithic may be taken forward by expanding our culinary vocabulary and refining the interpretive framework. Chapter 2 attends to the archaeology of the Upper and Middle Thames Valley, with special emphasis on pit sites. The four pit sites included in this project are also introduced. Chapter 3 attends to the ceramics of the fourth millennium BC. I outline the typological framework for Early Neolithic bowls and Peterborough Ware, and I argue that ceramic typologies of the period are puzzling due to poor understanding of the contexts of pottery manufacture and use. I also describe the pottery assemblages from the four sites introduced in Chapter 2. These pottery assemblages were sampled for food residues, and the techniques of residue analysis by GC/MS and GC/C/IRMS are described in Chapter 4. I discuss the ways in which lipid residue datasets are interpreted to help reconstruct pottery use, and I argue that this type of data relates first and foremost to cookery practices and pottery use. Recalling the discussion of our culinary vocabulary in Chapter 1, we see that terms like 'diet' are a poor match for food residue information. The results of food residue analysis of pottery from the four pit sites are presented in Chapter 5. It is clear that food and pottery belonged in the same social sphere in the fourth millennium BC and that potters responded to the needs of cooking. It follows that food residues may shed some light on the contexts of pottery manufacture discussed in Chapter 3. In Chapter 6, I bring together concepts and circumstances from the other chapters. I also discuss other food residue studies on pottery from the Thames region and the specific challenges that Neolithic pottery poses to the archaeological scientist.

# 1. What's cooking: food and the fourth millennium BC

*'Our most intimate contact with the natural environment occurs when we eat it'*

Fernández-Armesto 2002: ix

## 1.1 Introduction

This chapter sets the scene by considering the disciplinary context of the fourth millennium BC. The period is caught up in an ongoing debate about the character and tempo of the Mesolithic-Neolithic transition, and archaeological remains that date to the fourth millennium BC are repeatedly called upon to support different views of how the Neolithic began. In the first half of this chapter, I argue that dietary evidence is at the core of this debate. The reasons why dietary evidence is especially contested are revealed when we trace the concept of the Neolithic back through twentieth-century archaeological discourse. Further, I discuss the ways in which this legacy has impacted on interpretation of dietary information, and I suggest that this state of affairs is especially problematic when new scientific techniques are applied to the Neolithic record. Fresh approaches to dietary evidence will help us come to terms with some of the 'conflicting' datasets. Consequently, I suggest that our understanding of the fourth millennium BC will benefit from insights gained through an intensified archaeological interest in cultural aspects of foodways (e.g. Hamilakis 1999; Milner and Miracle 2002; Parker Pearson 2003; Twiss 2007, 2012; Isaksson 2010; Beaudry 2013). Such approaches complement processual concerns with diet and nutrition. A particularly promising line of enquiry is the increased emphasis on evidence for cooking and food processing in the archaeological record (e.g. Wright 2000; Atalay and Hastorf 2006; Rodríguez-Alegría and Graff 2012). The second half of this chapter is dedicated to the archaeological study of foodways. Here, I consider the wider academic context thereof and I briefly review the ways in which archaeologists have engaged with food evidence in the last few decades. I explore the labels that we assign to prehistoric food remains both in terms of the species consumed and the reconstructions we produce. The latter is especially relevant since the increased archaeological interest in food has resulted in an expanding vocabulary. Finally, I introduce a few themes that can enhance our understanding of foodways in the fourth millennium BC, including food culture hybridisation in contact situation and material culture as culinary equipment.

## 1.2 The fourth millennium BC

### *1.2.1 The dispute*

New features appear in the British archaeological record in the centuries after 4000 BC. Traditional components of the Neolithic repertoire – pottery, polished stone axes, houses, and domestic food species – are all represented by around 3700 BC (Whittle 2007). In Britain and elsewhere in north-west Europe, monuments of stone, timber, and/or earth are also a widespread and defining feature of the Neolithic. However, questions about the social and economic significance of the new features remain unresolved. The extent to which changes were uniform across Britain is also open to debate (Thomas 2004: 113). Two contradictory models are central, although there is some variation between accounts within each overarching model. In the traditional scenario groups of farmers arrived from mainland Europe shortly after 4000 BC and swiftly converted or expelled indigenous hunter-gatherer inhabitants throughout Britain (e.g. Childe 1940; Piggott 1954; Case 1969). This model explains the relatively sudden appearance of Neolithic features, as well as the contemporary decline of Mesolithic-style remains.

The traditional scenario of immigrating Neolithic farmers was challenged in a series of influential articles during the 1980s and 90s. For example, Kinnes (1988) assembled the available evidence for the ‘first’ Neolithic in Britain and suggested that the resolution of data was not fine enough to enable us to ‘disentangle process from circumstance’. In the same year, Thomas (1988) argued that the idea of a sudden transition was maintained at the expense of important cultural processes that both preceded and outlasted the 4000 BC landmark. He rejected two tenets of earlier accounts: firstly, that migrating farmers would have embarked on British shores replete with components of the Neolithic package, as envisaged by Humphrey Case in 1969. Secondly, the idea that Mesolithic populations abandoned their forager lifestyles and took up agriculture when crucial wild resources were in decline (e.g. Dennell 1983; Zvelebil & Rowley-Conwy 1986) was dismissed by Thomas in favour of explanations that emphasised ideological change and intensification of ceremonial life. By the 1990s, the fates of indigenous hunter-gatherers were firmly on the agenda (e.g. Armit and Finlayson 1992; Whittle 1996). Perhaps inadvertently these accounts echoed Piggott (1954: xv) in his suggestion that the conditions of the British Neolithic would have been profoundly influenced by the character of the Mesolithic. The second model of the transition thus places gradual adoption of Neolithic traits by indigenous groups at the core of change.

### *1.2.2 Recent approaches to the British Neolithic*

In the last couple of decades, the migration-model has undergone a facelift on basis of data from a variety of sources. For example, Sheridan (2003) has drawn attention to stylistic similarities between Early Neolithic pottery in northern France and western Scotland. She suggests that some of the Scottish ceramics pre-dates pottery found in England. Significant early assemblages of simple and carinated bowls have been recovered at, for example, the Sweet Track in Somerset (Coles and Coles 1986) and the Coneybury Anomaly in Wiltshire (Richards 1990). Unlike finds in Denmark and southern Sweden, none of the early British pottery has been labelled Mesolithic, perhaps because the first horizon of ceramics comprises skilfully made vessels. Sheridan argues that the pottery found at the chambered tomb of Achnacreebeag in Argyll, Scotland, is likely to have been brought from mainland Europe by a small community of agriculturalists. They, or their descendants, would also have constructed the tomb itself. The style of pottery and megalithic architecture are without precedents in the region. Thomas (2004: 117) rejects both data and interpretation of Sheridan's account and points out that 'even if we were to accept the culture-historic view of ceramic style as the manifestation of the cultural norms of a distinct population, these pots would be poor candidates for the diagnostic material culture of an immigrant population'. Sheridan (2007: 468) recently presented a more extensive set of evidence from both sides of the English Channel and while she accepts that no distinct donor group for her northern British 'Carinated Bowl Neolithic' has been identified in mainland Europe, she encourages the ongoing search for a 'target area'. Notably, the differences between Neolithic ways of life in colonised regions such as southern Scandinavia, Britain, and Ireland can be explained by rapid 'localisation' once the migrant farmers had arrived (ibid. 470).

Alongside this updated scenario of the migration-model, calls have recently been made for more nuanced approaches that move beyond the polarised debate (e.g. Robb and Miracle 2007; Garrow and Sturt 2011; Cummings and Harris 2011; Jones and Sibbesson 2013). For example, Garrow and Sturt (2011) dismiss the idea of an isolated British Mesolithic and draw attention to evidence for maritime connections across the English Channel and in the western seaways during the fifth and fourth millennia. The issue of directionality is addressed in that '[t]he process of transition had long term origins and a dynamic in both directions' (ibid. 69). Enhanced appreciation of multidirectionality of people, objects, and knowledge is crucial, as it has the potential to dismantle some long-held assumptions about the cause and character of the British Neolithic. For example, intermarriage of members of indigenous and incoming communities has been suggested as a component of coexistence following the settling of groups from the Continent (e.g. Whittle 2003). But perhaps family ties across the Channel were one cause – rather than a consequence – of the transition as we know it? The point is that our long-standing concern with immigration versus indigenous change has curbed some simple (yet archaeologically challenging) questions. In my view, more nuanced approaches that accommodate complex combinations of both scenarios are the most promising direction of current research on the British Neolithic.

Nonetheless, the idea of an abrupt transition persists. For example, Rowley-Conwy (2004) argues that the post-processual scenario of a slow, seamless transition is at odds with a growing body of data that points in the opposite direction. He maintains that '[t]he transition to agriculture was rapid and probably traumatic' (ibid. 83). An example of fresh data that backs this scenario of disruption is provided by recent work on radiocarbon date densities at Mesolithic and Neolithic sites, which are utilised as proxies for population size (Collard et al. 2010). The study rests on the premise that larger populations will enhance the number of site phases that are recovered archaeologically, and it indicates a sharp population increase after 4000 BC. Collard et al. (ibid. 867) argue that the documented surge in radiocarbon dates in south England and Scotland was too rapid to represent the 'learning curve' for uptake of agriculture and subsequent population boom among indigenous foragers. Indeed, the issue of whether new foods from domestic species quickly became part of people's diet is at the heart of ongoing debate.

### *1.2.3 The stable isotope scenario*

New kinds of material culture and architecture were introduced in Britain shortly after 4000 BC, regardless of the mechanisms behind their appearance in the archaeological record. It can be argued on basis of available evidence that these changes were not matched by an abrupt abandonment of wild foods (e.g. Whittle 2003; Thomas 2004, 2007). This would align with the idea of the transition as driven by indigenous groups, cherry-picking and transforming aspects of the north-western European Neolithic. In contrast, domestic plants and animals may have provided staple foods throughout the fourth millennium BC (Sheridan 2004; Rowley-Conwy 2004). This idea fits neatly into the model of abrupt change following the arrival of farming communities from the Continent.

The latter scenario has been considerably boosted by recent stable isotope studies that have targeted changing diets across the Mesolithic-Neolithic transition (i.e. Richards and Mellars 1998; Richards and Hedges 1999; Schulting and Richards 2002a; Schulting and Richards 2002b). The technique involves characterisation of the carbon and nitrogen stable isotopic composition of bone collagen from human and animal skeletal remains. The composition of bone collagen reflects an individual's protein intake during life. The dietary protein component can thus be reconstructed on basis of naturally variable occurrence of the stable isotopes of carbon and nitrogen. In Europe, the technique is applied to distinguish between marine- and terrestrial-based diets. The technique can also shed some light on the relative importance of plant and animal foods. In Britain, analysis of individuals from Mesolithic sites yielded predominantly marine isotopic values, while human remains from Neolithic tombs appeared to have consumed almost exclusively terrestrial foods. The authors suggest that this contrast signals a rapid introduction of domestic food species around 4000 BC (e.g. Richards and Hedges 1999: 894). However, discrepancies between isotopic and faunal evidence motivated a major critique of this scenario. For example, the faunal evidence indicates continued use of marine resources in Early Neolithic Scotland (Milner et al. 2004: 21-22). The isotopic scenario of abrupt change masks a series of methodological and interpretive problems, and these were highlighted in attempts to explain the contradiction between the different kinds of dietary evidence (Milner et al. 2004, 2006; Lidén et al. 2004; Barberena & Borrero 2005). The isotope technique is deceptively 'direct' since it sheds light on the foods eaten by an individual, but it does not necessarily generate a contextually meaningful picture. In fact, the studies of British skeletal remains relied on small and potentially unrepresentative samples. Importantly, similar work in Europe (e.g. Lubell et al. 1994; Bonsall et al. 2000; Borić et al. 2004; Lidén et al. 2004; Fischer et al. 2007) and Siberia (Katzenberg & Weber 1999) indicates that a larger body of samples tends to make interpretation less straightforward, rather than the other way round. That Mesolithic people in some parts of Britain consumed more fish, seafood, and sea mammals than Neolithic groups is a valid conclusion, but the character and speed of the change(s) cannot be addressed solely by isotopic analysis of dietary protein. In addition, the dataset does not support a rapid dietary shift since the body of samples represents a period of several millennia. Nonetheless, the isotope data added fuel to the dispute about the Mesolithic-Neolithic transition in Britain.

### *1.2.4 Seeds of contention*

It is unsurprising that the critical review of the isotope scenario was motivated by ambiguities of Neolithic faunal evidence. In fact, remains of domestic animal and plant species are also subject to some debate. In 1989, Moffett et al. set the scene by questioning the conventional model of a Neolithic farming economy. Their review of charred plant remains from sites in England and Wales demonstrated that domestic cereals were scarce compared to traces of 'collected food resources' and 'woodland food plants' (Moffett et al. 1989: 243, 245). Notably, this study relied on remains recovered through flotation, which at the time had only been standard practice for about a decade. The picture generated through systematic use of flotation is still valid. Cereal grains are generally present on Early and Middle Neolithic sites in Britain, but in small numbers compared to remains of wild plants. Hulled and naked varieties of wheat and barley are known, while the wild plant component is commonly dominated by hazelnut shells. Species such as crab apple, blackberry, and sloe are sometimes present. Accordingly, some scholars claim that cereal cultivation was a marginal activity and that wild plants continued to play an important role (Robinson 2000b; Thomas 2004). Others believe that cultivated cereals contributed significantly to people's diets across the British Isles from as early as 3800 BC (Jones 2000; Jones & Rowley-Conwy 2007; Brown 2007). Both views find support in the archaeological record. In addition, prior to the adoption of routine flotation the latter view also relied on cereal impressions on ceramics (Stevens and Fuller 2012: 709) combined with some extent of expectation. For example, Moffett et al. (1989: 243) pointed out that '[a]pple pip impressions were noted in pottery from Windmill Hill, but he [Halbaek 1952] did not find any other examples of food gathering so assumed that agricultural output in the Neolithic was sufficient for feeding the population'.

More recent insights that may help untangle this issue are provided by comparison of the palaeobotanical record of different periods and regions (e.g. Robinson 2000b; Stevens 2007). Regardless of the precise contribution of wild versus domestic plants to the overall diet, it is clear that the activities surrounding cereal cultivation were distinctly different in the British Neolithic as compared with those of later prehistoric periods in Britain. This is supported by a recent review of multiple lines of evidence by Stevens and Fuller (2012). They point out that environmental and pollen evidence from the Neolithic indicates intermittent and small-scale clearance and cultivation activities (ibid. 708). Other indicators of cereal cultivation such as storage pits, ard marks, and field systems are rare or unknown prior to the Middle Bronze Age. Moreover, dental and isotopic evidence from human remains indicate that Neolithic individuals consumed less carbohydrate-rich cereals and more animal source foods compared with later populations (ibid. 709; Richards 2000; Chamberlain and Witkin 2003; Nyström and Cox 2003; McKinley 2008). On the other hand, the strongest argument against minor dietary input from cultivated cereals in the Neolithic is to do with circumstances of preservation and recovery (Jones and Rowley-Conwy 2007). Nonetheless, the paucity of crop-waste such as chaff and weed seeds on Neolithic sites along with low numbers of hazelnuts on Bronze Age sites indicate that we are indeed looking at 'a real pattern of use' (Stevens and Fuller 2012: 710). In contrast, Middle Bronze Age and later sites commonly yield crop-waste, while hazelnut fragments are frequently found on Mesolithic and Neolithic sites. Thus a compelling case for a 'Bronze Age agricultural revolution' in Britain is made (ibid. 717). Importantly, this narrative does not support a slow but steady increase in cultivation towards an irreversible culmination in the Middle Bronze Age. Instead, the long-term picture is one of 'punctuated' cultivation practices (ibid.708). In short, this is a persuasive recast and contextualisation of the well-attested agricultural intensification of the second millennium BC (e.g. Moffett et al. 1989). The implications for Neolithic economies are returned to below, following a closer look at why the expectation of farming in the Neolithic is so persistent.

## 1.3 Tracing the Neolithic

### *1.3.1 Arts of subsistence*

Subsistence-based social divisions can be traced back to Classical times, although the categories we use today have their roots in the seventeenth century AD (Pluciennik 2001, 2004, 2008). According to capitalist and individualist doctrine emerging at the time, 'savage' societies lacked concepts of ownership and/or willingness to improve their situation through increased control over natural resources (Pluciennik 2001: 742). This reasoning justified colonial appropriation of land since much of it had not previously been brought into agricultural production. In Europe, the technology-based Three Age System became a contender to subsistence categories during the latter half of the nineteenth century AD. Around the same time, a social evolutionary scheme including at least three 'successive arts of subsistence' was put forward (Morgan 1877). Half a century later, Peake (1927: 22) argued that things had moved on: '[i]t was at one time believed that all civilized people had passed through three successive stages – the hunting, pastoral, and agricultural'. He went on to dismiss the tripartite scheme on the grounds that agricultural societies without domesticated animals had been discovered at two 'very early' sites in the Middle East. Therefore, the first cultivators of cereals must be given priority while the issue of animal husbandry is more suitably left aside. Indeed, the technology- and subsistence-based schemes were partly reconciled when the Mesolithic-Neolithic transition became synonymous with the shift from foraging to farming. Notably, this was due to a growing realisation that the long-term change from nomadic foraging lifestyles to fully settled food-producing societies would have taken many different routes and that the blueprint of successive stages could not be universally applied. However, in effect the tripartite scheme was replaced by a bipartite one, and the 'intermediate' group of semi-nomadic pastoralists was incorporated into the same category as settled agriculturalists.

Also in the 1920s, polished stone axes – the original symbol of the Neolithic – were brought into association with agriculture, sedentism, and pottery to form the Neolithic package. In the 1930s, Childe brought economic definitions to bear also on the Bronze and Iron Ages, yet it was the association between agriculture and the European Neolithic that would prove most influential (Pluciennik 2001: 749). During the second half of the twentieth century, the Neolithic package disintegrated as radiocarbon dates placed the appearance of its components far from each other in time (Higgs & Jarman 1969: 36). As a result, the conceptual core of the Neolithic became increasingly centred on agriculture and animal husbandry (Thomas 2007: 423). Other components of the Neolithic package could be rearranged around the fundamental distinction between foraging and farming. Today, European prehistory accommodates nonconformists such as Mesolithic Ertebølle pottery in Denmark (Hallgren 2004), domestic architecture at Mesolithic Lepenski Vir in Serbia (Jochim 2011: 139), and the aceramic Greek Neolithic (Milisauskas 2011). Considerable attention was granted to the validity of labels like Mesolithic and Neolithic during the twentieth century (Piggott 1954; Higgs & Jarman 1969; Zvelebil 1996, 1998; Pluciennik

1998), yet such scrutiny of the meaning of our concepts can also serve to reinforce them (Pluciennik 2008: 16). The hunter-gatherer category retains its status as a meaningful topic in anthropology, even though great diversity within the category is recognised (Barnard 2004a: 4). The bottom line is that the subsistence-dichotomy that both survived and was revived by twentieth-century discourse does not favour groups that practice some form of mixed economy.

As anticipated by Peake (1927: 21), the persisting distinction is that between foragers and food producers. Pluciennik (2001: 746) argues that the perception of 'an important difference – technical, social, mental, moral – between pre-farming and farming societies' has persisted, despite appreciation of the limitations of our categories. The status of such categories and the precise criteria by which a society can be fitted into one of them have varied over the last 250 years, yet subsistence 'has always remained available as an intellectual and cultural resource for classifying others' (ibid. 741). Moreover, the stark contrast between agricultural and non-agricultural societies aligns with a Cartesian nature-culture dichotomy. It is at the inception of the Neolithic that humans 'domesticate the landscape and its resources' (Pollard 2004: 56; Ingold 2000). Beyond academia, the roots of modern-day maladies like exploitation of the environment, inequality, and 'diseases of affluence' are traced back to the emergence of food production (Diamond 1997). This view of agriculture as the catalyst of a multitude of negative developments is a clear divergence from earlier accounts, according to which the invention of farming was a shift from parasitic to more symbiotic relationships with plants and animals (Peake 1927: 21; Childe 1942: 55). The modern-day perception of hunter-gatherer societies as operating according to more egalitarian ideologies, in which individualistic wealth accumulation is a threat to the social order, finds some support in ethnographic literature (Barnard 2007). Their political and academic rehabilitation from the 1960s onwards probably served to enforce the dichotomy, and foragers and farmers continue to be researched on very different terms (Pluciennik 2001). The transition from one mode of subsistence to the other represents a clash of two mutually exclusive concepts. Consequently, the ongoing debates about incipient farming in Britain and elsewhere in Europe (e.g. Bonsall et al. 2004; Borić et al. 2004) testify to the interpretive challenges posed by societies that do not fit comfortably into either category.

### *1.3.2 Scales of analysis*

The strong association between farming and the Neolithic has turned domestic food species into signals for the onset of the Neolithic in the archaeological record. Accordingly, radiocarbon-dated first appearances of domestic plants and animals can help map out the spread of the Neolithic across Europe. In their seminal paper, Ammerman and Cavalli-Sforza (1971) estimated that agriculture spread across Europe by approximately one kilometre per year. Their conclusion is confirmed in recent studies that rely on more substantial datasets, and this time round regional variation and the tension between large- and small-scale observations are highlighted (e.g. Gkiasta et al. 2003; Pinhasi et al. 2005). The annual advance of around one kilometre may seem dramatic, but given the distances involved the spread of agriculture to the north-west fringes of Europe took over 3000 years. Subtleties emerge as our scales of investigation are refined, much thanks to improved applications of scientific techniques such as stable isotope and aDNA analyses (e.g. Bentley et al. 2003; Bramanti et al. 2009; Haak et al. 2010; Shennan 2013).

However, this should come as no surprise; diversity was clearly anticipated by many earlier scholars. The explicit emphasis on the bigger picture adopted in many culture historical and processual accounts of the Neolithic transition does not by default deny regional diversity and complexity at the smaller-scale. Ammerman and Cavalli-Sforza (1971: 686) noted that, alongside the generalised pattern obtained by their own approach, 'there must have been considerable opportunity for the development of local cultural variation and adaptation'. Childe (1936 [1981, chapter 5]), who promoted the concept of a Neolithic Revolution, acknowledged the discrepancy between what he envisaged as a lengthy process of domestication and the scanty traces thereof in the archaeological record. In his view, only the culmination of such a process can be detected, whereas the finer details of events that precede it are lost to the archaeologist. He recognised that terms such as 'cultivation' and 'mixed farming' conceal a great deal of diversity. Later on, Piggott (1954: xv) complained that 'many of us today feel that our archaeological terminology is in serious need of revision and that such phrases as 'Neolithic' … have a rather dubious validity'. Similarly, Higgs and Jarman (1969: 32) pointed out that 'when such an artificial taxonomic line is created [as that between Mesolithic and Neolithic] subsequently it may be used as if it were an absolute division, a usage which obscures the fact that in reality there is an important and steady gradation from one class to the other'. The details are brought to the fore as our scales of analysis decrease, yet in parts of Europe disagreement about the nature of the transition has deepened. The bottom line is that the authors of seminal pieces of work on the European Neolithic *knew* that the model is flawed. In this respect, many culture historical and processual accounts are more theoretically sophisticated than some of the recent accounts. The irony is that the earlier scholars did not have access to the scientific techniques that allow reconstruction of the details that they so clearly anticipated.

The immigration-hypothesis for the transition to the British Neolithic is attractive because it turns the transition into a recognisable event (Clark 1966; Case 1969). A cursory reading of seminal literature on the Neolithic would support the notion of a disruptive transition. This notion of sharp contrasts between 'Mesolithic' and 'Neolithic' lifestyles sometimes influence archaeological interpretation. For example, in their discussion of carbon and nitrogen stable isotope datasets, Schulting and Richards (2002a: 1023) suggest that 'if we can make the reasonable assumption that the exploitation of marine resources continued into the Late Mesolithic with at least the same intensity as seen in the earlier part of the Mesolithic, it is clear that the appearance of the Neolithic saw a sharp shift in economic practice'. However, if we question that assumption we are potentially looking at an entirely different picture. The off-hand assumption of homogenous food practices throughout the Mesolithic is deterministic. Interpretation of the stable isotopic data was clearly influenced by simplistic models of the two periods, and in turn the isotopic scenario reinforced those models. Notably, this data is the only positive body of evidence that has been severely questioned. Settlement and grain cultivation evidence has also been disputed (e.g. Darvill 1996; Thomas 1996; Jones and Rowley-Conwy 2007; Stevens 2007) but *absence* of evidence has been crucial in these discussions. The strong and persistent association between farming and the Neolithic is responsible for this ongoing search for a crisp division between Mesolithic and Neolithic foodways.

### *1.3.3 Implications for the fourth millennium BC*

Both main explanations for the transition and Early Neolithic in Britain are based on sound datasets or, in some cases, a conspicuous lack of evidence for Neolithic lifestyles. The dispute is to do with what the evidence *means*. The rapid-transition scenario accommodates some wild foods, because in this view blackberries and seafood is not a salient expression of forager identity when eaten alongside bread and milk. The presence of domestic food species, no matter how modest their contribution to the overall diet, is sufficient indication of radically new social arrangements and relationships with the environment. In contrast, the other scenario relies on the notion that wild foods consumption disqualifies a society for a traditional (agricultural) Neolithic label. In my view, the transition to agriculture in Britain was not uniform or rapid. In 4000 BC cereals were certainly grown in places where no cereals had been grown before. The earliest cultivators were probably born in mainland Europe. Cereal cultivation may not have been unknown to the indigenous population – we have seen that there is evidence for Mesolithic cross-Channel contact (Garrow and Sturt 2011). So why does the tempo of change accelerate in the early fourth millennium? Was it population pressure (e.g Moffett et al. 1989) and social discord on the mainland that motivated people to move across the English Channel? In any case, the interactions that ensued between newcomers and natives would have changed everyone involved, and the distinction between them soon faded. It is the complex outcomes of such interactions that we see in the archaeological record. The question is not 'how?' but 'why now?' and 'what happened next?'.

There are flaws also with the scenario of indigenous change. For example, despite wide acknowledgement of some dietary continuity from the Mesolithic little has been done to characterise these lingering food preferences. In addition, to label cattle and cereals as signifiers of explicitly 'new' identities, consumed exclusively at highly visible but sporadic feasts, does not advance our understanding of everyday meals. A disruptive shift to agriculture around 4000 BC cannot be sustained, although profound changes are underway from the close of the fifth millennium. New foods from managed animals and plants are central in these transformations. Yet the emergence of 'land-extensive and labour-intensive cereal farming' belongs in the Middle Bronze Age of the second millennium BC (Stevens and Fuller 2012: 717). Consequently, for two and a half thousand years inhabitants of Britain occupy an economic grey area. Smith (2001: 6) has discussed the 'categorical misfits' that are 'reclassified out of existence' when we adhere to the bipartite subsistence scheme discussed above. In parts of North-America, prehistoric peoples defy such classification for up to 5000 years (ibid.). In Britain, interpretation of food remains in the Neolithic record has been hampered by an enduring concern with century-old subsistence categories that are difficult to reconcile with the archaeological record. Attempts to fit available evidence into the preferred scenario have resulted in shopping list approaches to food-related information. In other words, it does not matter how or why foods made from grains, cattle, or nuts were consumed, so long as they are *there* in the archaeological record. These are the reasons why further engagement with food remains of the fourth millennium BC is warranted. Inspiration and tools for further interrogation of food evidence from the fourth millennium BC requires us to look beyond the British Neolithic to wider food studies and to food archaeologies elsewhere.

## 1.4 Food in archaeology

### *1.4.1 Histories of food research*

Work by Claude Lévi-Strauss in the 1960s is often highlighted as an important catalyst for studies of the cultural meanings of food (e.g. Mennell et al. 1992: 8; Wood 1996: 8; Caplan 1997: 1). Since then, a string of influential anthropologists and sociologists, including Mary Douglas, Roland Barthes, and Pierre Bourdieu has granted thoughtful attention to the social dimensions of food and eating (Wood 1996). In anthropology, this enquiry has 'matured enough to serve as a vehicle for examining large and varied problems of theory and research methods' (Mintz and Du Bois 2002: 100). Something similar can be said for archaeology. Twiss (2007) outlines the trends in archaeological approaches to food that have developed in accordance with processual and post-processual priorities. In the processual vein, the foodways of a society are 'products of behavioural tailoring to specific environments', and these are addressed in terms of 'community subsistence' (ibid. 4). Processual engagement with food is heavily influenced by nutritional science and ecology (e.g. Clark 1954; Dennell 1979). Twiss (2007: 4) suggests that '[h]ealth is considered to be an objective state and one automatically recognized and sought out by human populations (…) food selection is aimed ultimately toward the optimization of physical health'. The social value of food is therefore measured by its nutritional content (ibid.; Hamilakis 1999). Also in the processual vein, evidence for feasting has been explored for its potential for cross-cultural analysis. In this view, feasts would serve to display and reiterate the power of those members of a community who are able to invest the necessary time and resources (e.g. Hayden 2001). If, on the other hand, an entire community participates equally in a feast, it may reinforce shared notions of group identity or ritual commitments. In contrast, post-processual or interpretive archaeologies have been more concerned with culturally specific contexts of food, sometimes with an emphasis on, for example, feminist interpretation (e.g. Claassen 1991). Complex links between food and socioeconomic status have been explored repeatedly (Twiss 2007: 6). Symbolic or ceremonial aspects of food and eating have also preoccupied post-processual archaeologists, although – unlike the processual study of feasting – the development of universally applicable phenomena is not a priority (e.g. Politis and Saunders 2002; Ray and Thomas 2003). Food and identity is another recurring theme (e.g. Janik 2003; Valamoti 2003; papers in Twiss 2007).

Thus contemporary archaeological approaches to food in the material record are extremely diverse, and European prehistory is strongly represented (e.g. Out 2008; Russ et al. 2008; James 2009). However, to some extent a division persists between scientifically driven and theoretically motivated approaches. The example above of the stable isotope investigations into British prehistoric foodways illustrates that dissonance may arise when we try to reconcile scientific datasets with complex and contextually varied information. Similar analytical divides are evident in sociology (Wood 1996: 2) and anthropology (Mintz and Du Bois 2002: 101). It also reflects wider academic arrangements, as illustrated by the omission of natural sciences in a recent multidisciplinary overview of food studies on the grounds that 'most biologists, food chemists, and other scientists do not yet participate in the dialogue of critical food studies' (Albala 2012a: xv). In prehistoric archaeology, the implication is that datasets obtained through laboratory analysis (including analysis of organic residues, stable isotopes, and phytoliths) are more likely to be interpreted within processual frameworks. Labour divisions in archaeology tend to impede theoretically well-informed and contextually sound interrogation of, say, biochemical datasets (Jones 2001). At the same time, food sustains both social and biological life and as such it lends itself to more integrative study.

Regardless of whether our approach is science-heavy or theoretically rigorous – or both – archaeological reconstructions of foodways are a form of food history. Food historians study the ways in which food shapes and is shaped by social, economic, and political forces (Haber 2004: 361; Claflin and Scholliers 2012). They often focus on themes that intersect several academic disciplines in order to explore how the theme is acted out through, for example, food policy and culinary culture (e.g. Inness 2001). Themes such as gender or industrialisation are thereby addressed. In this vein, food species in the archaeological record are associated with certain behaviours, social arrangements, and settlement patterns. The primary aim is to illuminate the theme rather than the food itself. However, food history accommodates the subfield of culinary history, which is concerned with 'what people in the past actually cooked, how and where food was served, and what particular dishes meant to the people who ate them' (Albala 2012b: 119). It takes place in the kitchen as well as behind a desk, and relies primarily on gastronomic literature such as historic cookbooks, menus, and farming or medicinal writings (e.g. Wheaton 1983; Willan 2000). The distinction between the sets of approaches is eroding as food historians and other researchers are increasingly tapping into this reservoir of culinary knowledge. Indeed, ‘without a real sense of what is involved in the preparation of a dish – the labour, the techniques of cooking, and the knowledge of ingredients and their history – professional scholars run the risk of making serious errors of fact and interpretation’ (Haber 2004: 363). Consequently, insights from this field have the potential to enhance archaeological understanding of past cookery practices. With this in mind, this project is concerned with the social and technological processes by which plants and animals become food, specifically through transformations in ceramic vessels. Such an enquiry requires some terminological clarification.

### *1.4.2 Food labels I: the animals and plants*

We have seen that different plant and animal species have become signals of different lifestyles in the ongoing debate about the British Neolithic. But what are they signals of? In his discussion of what qualifies as a wild animal, Kramer (2006: 184) asks ‘what exactly are we invoking when we apply the predicate ‘wild’? Is it a quality of the animal itself? Is it a quality of our subjective experience? Is it some kind of reference to the environment things live in? Does it refer to its life history? Is it something about their relationship to human beings? Is it a reference to the dangerous or mysterious quality of something?’ Kramer’s concern is whether the elks he hunts on a Colorado game ranch are truly wild, but I suggest that each of his definitions of wildness have been explored archaeologically. For example, the wild animal itself is identified as non-domestic on basis of genetic and morphological attributes (e.g. Albarella et al. 2007). Life histories of wild species are defined by their lack of the ‘sustained human agency in the propagation and care of plants and animals’ (Zeder et al. 2006: 139) that characterises domesticates. In addition, Whittle et al.’s (1999) interpretation of Windmill Hill situated the tamed and socialised inner circuits of the causewayed enclosure within an unsocialised and dangerously wild ‘world of nature’. However, a strict separation between ‘wild’ and ‘domestic’ maintains a modern Western nature-culture dualism that is of questionable relevance to the Neolithic. Pollard (2004: 60) argues that although certain features of the Early Neolithic faunal record do indeed indicate a conceptual split between wild and domestic animals reminiscent of our own, such conclusions ‘must be resisted’. Even so, human-animal relationships must have changed with the introduction of new and closely managed species (ibid.; Jones 1999, 2004; Jones and Richards 2003; Ray and Thomas 2003). The relationships that emerged would have been unfixed and localised: ‘[d]epending upon the species and context of the encounter, people could have had many different relationships to animals during their lifetime, as herders, custodians, hunters, consumers, even companions’ (Pollard 2004: 61). This project focuses in particular on the humans as *consumers* of food from a variety of plant and animal species.



**Figure 1.1** Food webs in science, education, and art. From Benke and Wallace 1997 (top), Amsel 2012 (bottom left), and artwork by Josephine Vejrich (bottom right).

Food consumption took place within complex webs of human interaction with plants and animals. This complexity is not adequately accommodated within the antithetical labels of wild and domestic. Instead, more helpful frameworks may be adopted from theoretical ecology, in that humans, plants, and animals form dynamic food webs that may be interrogated archaeologically (fig. 1.1) (Jones 1992). Humans are not the only consumers in such webs, and from an archaeological point of view the diet of certain animals is of interest. For example, isotopic analysis of aurochs and cattle from fifteen English Neolithic sites suggests that they grazed in separate habitats, with the former feeding in forests and marshy areas as opposed to the pastures where domestic cattle were kept (Lynch et al. 2008). A change of fodder – from grass to dry hay, for example – can impact on the taste, consistency, and colour of milk (Iddison 2000; Green 2000). In the ecological approach, the food web can be characterised by the degree of interconnectedness it contains (Jones 1992: 214). The food webs in which humans participated contracted throughout British later prehistory, with people in the Neolithic relying on a wider range of foods than the farming communities of later periods (ibid.). In turn, the carbon and nitrogen stable isotope datasets demonstrate that Neolithic diets were more homogenous and restricted across Britain compared with the dietary breadth of the Mesolithic (Richards and Schulting 2006: 448; Milner 2006: 66). Dietary stable isotope values from Neolithic-period individuals tend to cluster, whereas the Mesolithic-period values are more scattered. However, this may be partly due to the fact that a plot of Mesolithic individuals will contain data from several different sites, while Neolithic sites generally yield multiple individuals that may be sampled. That is, regional variation may account for some of the diversity detected in Mesolithic-period isotope values. Nonetheless, pre-Neolithic food webs were highly interconnected, with high proportions of 'theoretically possible feeding links' (Jones 1992: 214). To some extent, this interconnectedness persisted also through the Neolithic. Agricultural intensification from the Middle Bronze Age meant further food web contraction. In the historic period, food webs expanded to include a wider range of hunted animals (ibid.).

A more comprehensive shift away from wild resources is in fact relatively recent. Wild animals such as fish, sea mammals, game, and fowl were esteemed banquet items in the late Middle Ages in Europe (Albala 2006: 9). In the following centuries the cultural value of such foods diminished, and by the 18$^{th}$ century many wild species had disappeared off the menu. To an extent, this development was to do with expanding acreages of cultivated land and increased cattle rearing. Wild species were marginalised as the supply of food to growing urban populations became increasingly dependent on higher yields from domestic species. At the same time, a cultural and intellectual shift in which taming nature became the 'conceptual ideal' was underway (ibid.). A preference for smaller cuts of softer foods that were made from white meat and bland vegetables emerged. The question of cause and effect is unresolved: '[t]he change in mentality may have been triggered by these material factors, or one could say conversely that a new relationship to nature and the willingness to subdue and master it for the benefit of humans is what ultimately led to the economic and social changes' (ibid.). Either way, the marginalisation of wild foods from the early modern period onward helps explain our apprehension towards joint occurrence of wild and domestic food species in the prehistoric record. Wild food remains from the Neolithic are especially ambiguous since farming is a defining feature of the period. In contrast, utilisation of wild foods in later periods is not an issue. Some consumption of species such as rabbit or chestnut does not undermine our vision of the Iron Age or the Anglo-Saxon period.

Returning then to the plants and animals within Neolithic food webs, the degrees of human interaction with different species can be situated along a spectrum that accommodates the wild, the domestic, and those in-between. At one end we find the animals that were associated with danger and/or taboos. That is not to say that the same animals (and possibly plants) occupied that space throughout the fourth millennium and across Britain. Equally, taboos may not have applied to all members of the community; age and gender status may have dictated the 'rules of engagement' (Pollard 2004: 61). Certain plants may have been under some form of human management without qualifying as 'true' domesticates. For example, hazel coppicing produces raw material for things like wattles, and the re-growth attracts animals such as rabbits and deer. At the other end of the spectrum, we find the food species that were closely managed by humans. Again, such arrangements were not fixed. For example, cereal grains were planted and harvested by the first generations of settlers from mainland Europe yet, as outlined above, cereal cultivation was largely abandoned by their descendants (Moffett et al. 1989; Stevens and Fuller 2012). The spectrum or web of human, plant, and animal populations shifted accordingly.

There is some debate as to which position on such a spectrum the most important food species occupied (e.g. Thomas 2004; Jones and Rowley-Conwy 2007). Did managed or unmanaged plants and animals provide staple foods? Either way, we are simplifying a concept that could enhance archaeological interpretation. The term ‘staple’ has been variously used across Europe in the last few centuries; it is associated with fruitfulness in the Slavic languages, with basic foods in French, and with markets in Romanian (Botsford 1990: 1). The English word was also originally connected to the marketplace, but its meaning has transformed to primarily denote the foods on which a society *depends*. Presumably, this is what archaeologists mean when they debate the issue of Neolithic staples. Moreover, the concept of staples is strongly associated with stability and stored foods. Thus staples are ‘foods which by tradition are thought to be necessary and therefore to be made available, even if they have to be stored’ (ibid.). Yet Botsford (ibid. 2) is ‘not at all sure that different cultures share the same notion of necessity’. The main function of a staple may not be to stave off starvation. For example, sugar, salt, and oil are modern-day staples in many parts of the world, but a lack thereof would not put people’s lives at risk. Shortage of a staple food may simply result in temporarily increased consumption of foods that would otherwise be considered unpalatable or somehow inappropriate. However, that is not to say that the social implications of a staple food shortage would be insignificant. Yet since the inhabitants of Neolithic Britain are unlikely to have starved, other kinds of ‘necessities’ must be at play. Were ‘staples’ the foods without which routine meals could not be prepared? Were they the foods that upheld social order when displayed and consumed at large, seasonal gatherings? Or were they in fact the foods that sustained people through winter? In a society that is not on the brink of starvation the establishment of a staple food is more to do with eating preferences than with survival: staples are ‘a matter of taste, convenience, accessibility, and tradition’ (ibid. 4). Thus the question is not which foods *were* necessary for survival in Neolithic Britain, but rather which foods people considered to be necessary.

### *1.4.3 Food labels II: reconstructions*

Shopping-list approaches to food remains in archaeological record are increasingly recognised as inadequate, and a growing number of archaeologists are attempting to take the evidence further. For example, archaeobotanists have long since moved on from simply addressing presence or absence of domestic cereals to also look at the activities that surrounded cereal processing (Palmer and van der Veen 2002: 195; Fuller 2010: 10). Milner (2006) has considered Mesolithic foodways in terms of taboos, menus, cooking, and feasting. This increased interest has resulted in a more elaborate vocabulary, with concepts such as ‘cuisine’ and ‘gastronomy’ being applied to archaeological evidence. In addition, our more common terms have proved troublesome – and again the debate that ensued over the stable isotope data from the British Mesolithic and Neolithic provides an example. Confronted with evidence of marine foods exploitation in the Neolithic, Richards and Schulting (2006: 445) argue that ‘[r]emains of fish and shellfish recovered from archaeological sites are the remains of individual meals, but are not indicative of the overall diet of a human population’. Yet an overall diet is of course made up of individual meals (Milner et al. 2004: 19). Confusingly, data from the consumers does not match the remains of the consumed. Moreover, the humans and the animals they ate have both been referred to as the most ‘direct’ measure of past diets (e.g. Richards and Schulting 2006: 445; Smith and Brickley 2009: 118; cf. Albarella and Serjeantson 2002: 33; Rowley-Conwy 2000). However, the question of whether isotope values or faunal remains are the most accurate measure of Neolithic diets is not a problem that needs to be resolved. The ‘contradiction’ does not imply that one dataset is erroneous (Barberena and Borrero 2005). Instead, it reflects the transition and associated periods as characterised by multiple intersecting strands of practices, among which ‘conflicting’ lines of evidence should be expected (Jones and Sibbesson 2013).

When we aim to produce a broad picture of the food species utilised by a human population, terms such as ‘diet’ or ‘subsistence economy’ will suffice as they refer to the species utilised and, sometimes, the manners of their procurement. On an individual level, ‘diet’ refers to all that is eaten over a period of time (Isaksson 2010: 40). An individual’s diet may be considered in terms of childhood versus adult diet, given the development of sampling techniques for stable isotope analysis that distinguishes between signals from different stages of life (Eriksson and Lidén 2013). ‘Foodways’ is at once a wider and a more narrow term. It is broad because it includes all food-related activities of a community, from procurement and preparation to consumption and discard (Schulting 2008: 91). It is narrow because it may involve the fine-grained details of, for example, butchery or cooking activities. Accordingly, the term ‘foodways’ can be used to either gloss over or examine a wide range of activities. Its potential lies in the recognition that the interpretive value of food goes beyond the procurement stage. Indeed, the confusion stirred up by the stable isotope dataset illustrates that exploration of those elusive meals is overdue: ‘[p]eople do not eat species, they eat meals’ (Sherratt 1991: 221).

To this end, terms specific to cooking and food processing are valuable. For example, ‘cuisine’ encompasses the range of socially laden activities that a society engages in to make food items digestible, appropriate, and palatable (e.g. Smith 2007). Santich (1988: 38) defines the term as ‘the whole sequence of operations which culminates in the presentation of prepared food, and represents the transformation of raw ingredients’. However, the term ‘cuisine’ is ‘effectively valueless unless a qualification is added’ (ibid.). It becomes meaningful only when we specify what type of cuisine – e.g. French, nineteenth-century – we are referring to. In my view, the term ‘cuisine’ carries strong connotations of elaborate cooking and refined tastes, perhaps involving ingredients that symbolise national dishes or social class. In addition, it implies a level of detail that the prehistoric record cannot deliver. Nonetheless, ‘cuisine’ helpfully shifts focus away from species-lists to the social settings in which they were processed and consumed. Along the same lines, ‘gastronomy’ denotes ‘the how, what, and why of eating and drinking’ (Santich 2007: 53). Despite not being wholly applicable to the prehistoric record, concepts such as cuisine and gastronomy remind us that people eat on ‘motives unconnected with hunger’ (ibid. 54). They relate to ‘the exercise of options [and] the expression of preferences’ (Santich 1988: 38). Another definition holds that ‘if a people cooks and recognises a common set of recipes and discusses them with a common vocabulary, then it should be deemed a cuisine’ (Albala 2011: x). It is relevant on various scales as ‘a nation, continent, region, and even a small group may share a common cuisine’ (ibid.). Perhaps most intimately ‘[e]ach meal companionship knows what a specific dish should taste like, a knowledge that is recreated at each meal’ (Isaksson 2010: 6). In a wider sense, culinary practices are informed by what may be referred to as ‘food culture’, which refers to ‘the social context of consumption, the shared values and symbolic meanings that inform food choices, and the rituals and daily routine’ (Albala 2011: x). For archaeological purposes, ‘cookery’ is a useful concept as it accommodates the activities, foodstuffs, and material culture involved in cooking and food processing. Cookery practices leave traces in the prehistoric record and may shed light on the culinary frames of reference that guided them.

### *1.4.4 Becoming food*

Atalay and Hastorf (2006: 283) remind us that ‘[f]or plant, animal, and mineral things to be eaten, they must first be culturally constructed’. Such cultural construction refers both to the fundamental definition of a plant or animal as edible and to the transformation that it is subjected to through cooking or other processing. An interpretive framework for cooking and food processing evidence in the archaeological record is emerging, primarily through the work of scholars in the US, and plenty of scope remains to bring this to bear on British prehistoric remains. Rodríguez-Alegría and Graff (2012: 2) distinguish between cooking and food processing, in that cooking involves heat alteration of foodstuffs through roasting, boiling, parching, frying, smoking, and baking. Food alteration without heat is achieved through, for example, pickling, salting, soaking, and fermentation. Other food processing procedures include butchering, cutting, grinding, and milling. Foods that are eaten raw generally undergo some form of processing as well – it may be peeled, sliced, mashed, and so on. In other words, humans interact with their food in a myriad of ways, and this interaction often involves material culture of some kind. The classification of procedures relates to the transformations that people affect onto foodstuffs in order to achieve food that is palatable, culturally appropriate, and storable. Atalay and Hastorf (2006: 293), on the other hand, list a series of stages that most foods go through as a community feeds itself: production and procurement, processing, cooking, presentation, and consumption. The distinction between production and procurement is, presumably, that procured foods are those not intentionally cultivated or managed. Taken together, these approaches equip us with a detailed language with which to interrogate the evidence. However, I would add *discard* to the list of stages. Indeed, Isaksson's (2010: 5) 'food culture model' describes the flow of food signals from species in nature, through storage and/or preparation contexts, and finally to either a sedimentary or anatomical context through additional transformations by burial or consumption. Food signals of the anatomical context are detected archaeologically by analysis of dental ware, dental calculus, or carbon and nitrogen stable isotopes. The sedimentary context contains macroscopic food remains along with associated material culture and biomolecular traces. The aim is to represent both the social and the taphonomic processes that alter the food we wish to study archaeologically. In other words, detailed attention to the many stages that food went through before and after consumption in the past will enhance interpretation of archaeological datasets. Not all transformations will be equally represented, and not all contexts are conducive to preservation or analysis. Nonetheless, the complexity that the model presents underlines the strong potential of foodways to shed light on past lives.

Despite this potential, food practices beyond the procurement stage are curiously overlooked in prehistoric archaeology. This may be due to a lack of confidence in the evidence itself, although unhelpful attitudes may also be accountable for this negligence. Rodríguez-Alegría and Graff (2012: 1) draw attention to Aristotle's referral to cooking as a 'menial art'. They argue that this 'characterization of cooking, albeit in translation, is an activity that is not prestigious and perhaps does not require superior skill. (…) The idea that cooking, especially within the household or by extension within preindustrial societies, was a necessary activity but not an honourable or skilful one has been the prevailing attitude toward cooking in archaeological contexts and a contributing factor to the lack of studies on cooking or food preparation'. We associate it with women, servants, and slaves. Thereby it is not generally considered to shed light on aspects of political life or ceremonial practices. Unsurprisingly, when archaeologists began to pay attention to cooking and consumption – as well as to food production – it was through study of publicly visible, political events such as feasts. Yet cooking and food processing practices draw on, reproduce, and transform the cultural context in which they are carried out, regardless of the number and status of participants.

To redress this in the context of the British Neolithic, Beaudry's (2013: 287) emphasis on ceramic vessels as culinary tools is essential. The Neolithic record lacks many of the lines of evidence for food processing that are available elsewhere, such as organic containers and implements like spoons and fishing equipment. Ceramics, on the other hand, are comparatively abundant. However, conventional approaches to ceramics centre on stylistic or chronological insights. Organic residue analysis of food residues from ceramics has added another dimension to ceramic studies, and I discuss this in chapters 4 and 5. Beaudry's (ibid.) discussion of the hybridization of foodways that occurs in the aftermath of intercultural contact is also relevant. She (ibid. 295) suggests that food can be 'both a catalyst for cultural mixing and a flashpoint for resistance against cultural imperialism'. Driver (1983: 95) developed a framework for 'predicting the performance of different immigrant cuisines lodged in countries friendly or hostile'. He identified five food culture characteristics that may help in addressing the arrival and evolution of novel foodstuffs and cookery techniques: differentiation, propensity to evolve, imitability, accessibility, and vulnerability. First, differentiation between indigenous and immigrant food cultures refers to, for example, different foodstuffs or different manners of preparation of the same foodstuffs. In addition, food may be differently allocated within a community depending on age or gender, although such differentiation may not 'survive export' (ibid. 96). Second, propensity to evolve is the degree of resilience against the forces that may encourage food culture change. In a modern context such forces may be related to import regulations or marketing strategies, whereas environmental or socio-political forces may be significant in a (pre)historic setting. Driver discussed the third characteristic, imitability, in terms of dissemination of culinary knowledge through cookbooks and television. Fourth, accessibility is 'a factor more cultural than culinary' (ibid. 97). It refers to the social settings in which immigrant food is presented to those unaccustomed to it. For archaeological purposes, the immigrant food culture characteristics of imitability and accessibility are better considered in terms of exposure to new foodstuffs and/or manners of preparation. This is a reciprocal process as both indigenous and immigrant peoples are exposed to unfamiliar foods. Finally, on the vulnerability of an immigrant food culture, Driver (ibid. 97-98) noted that '[f]rom the standpoint of a community relations specialist, rapid assimilation (…) to the host culture is theoretically desirable. But only social scientists with defective taste buds actually think on lines like these, and anyway, even in this field other experts would now argue that in a fundamentally hostile social environment, an immigrant people that keeps its cuisine intact (…) enjoys a better prognosis, communally speaking, than one that has let its historical identity go: it is a question of human dignity'. Among other things, the British Early Neolithic is the story of immigrant cuisine(s) and food culture hybridisation.

## 1.5 Conclusion

Three decades ago, Richard Bradley (1984: 11) commented on the dissonance between contemporary research priorities when he said that 'successful farmers have social relations with one another, while hunter-gatherers have ecological relations with hazelnuts'. Today, Mesolithic and Neolithic inhabitants of the British Isles have acquired complex relationships not only with each other, but with their tools, their dead, and their own bodies. However, ecological – or otherwise – relations with food have been largely ignored. At the same time, the set of scientific techniques that target food remains has expanded. A growing body of evidence indicates that Neolithic and Early Bronze Age foodways were unlike both Mesolithic forager diets *and* agricultural economies from the Middle Bronze Age onwards. The 1989 paper by Moffett, Robinson and Straker was influential because it made explicit the poor match between archaeological models and the archaeological record of Neolithic economies. The need for new perspectives is amplified by recently updated datasets that show that farming economies of the British Neolithic failed – or at least failed to make the impact that we expect to find in the archaeological record. I argue that we are still struggling with the *meaning* of all this. Our interpretive frameworks for dietary evidence are anchored in subsistence models that were articulated several centuries ago and reinforced during the 20th century. This project centres on one main implication of the mismatch between our disciplinary legacy and the available evidence; Neolithic food cultures remain underexplored, despite the recent scientific emphasis on 'diet'. To redress this, special emphasis on the processes by which plants and animals become food is constructive. Such an approach helps to resolve the discrepancy between the consumer and the consumed in the Neolithic archaeological record.

# 2. The Upper and Middle Thames Valley

## 2.1 Introduction

In 1988, Robin Holgate suggested that the Thames Valley was a promising region for elusive traces of Neolithic settlement. Holgate (1988: 1) dismissed existing accounts of domestic life as 'little more than guesswork' and argued that Neolithic archaeology was dominated by monuments, burials, and well-made 'exotic' artefacts. The archaeology of life beyond the monuments still relied on 'the study of flintwork recovered largely from the ploughsoil' (ibid. 33). Since then, developer-funded investigation has shed considerable new light on prehistoric occupation in the Thames Valley. Good preservational conditions and high standards of recovery at a few large-scale excavations have brought the Thames Valley Neolithic into sharper focus. The Thames itself is one of the most extensively studied rivers in the world (Brown 1997: 150). Forty years of study has produced a detailed geo-hydrological framework for interpretation of archaeological remains (e.g. Green and McGregor 1980; Bridgland 1994). Today's river valley landscape is a product of three thousand years of intensive occupation and cultivation. Anthropogenic landscape changes that accelerated towards the end of prehistory have implications for the preservation and recovery of Neolithic remains. In this chapter, I describe Early and Middle Neolithic archaeology in the region. I discuss the significance of pits in the Thames Valley and beyond, and I introduce the four pit sites studied in this project: South Stoke, St Helen's Avenue at Benson, Horcott Pit, and Cotswold Community. All four sites were excavated in the last fifteen years in advance of quarrying and development. Holgate's prediction that the region contains plenty of evidence of Neolithic everyday lives has been confirmed.

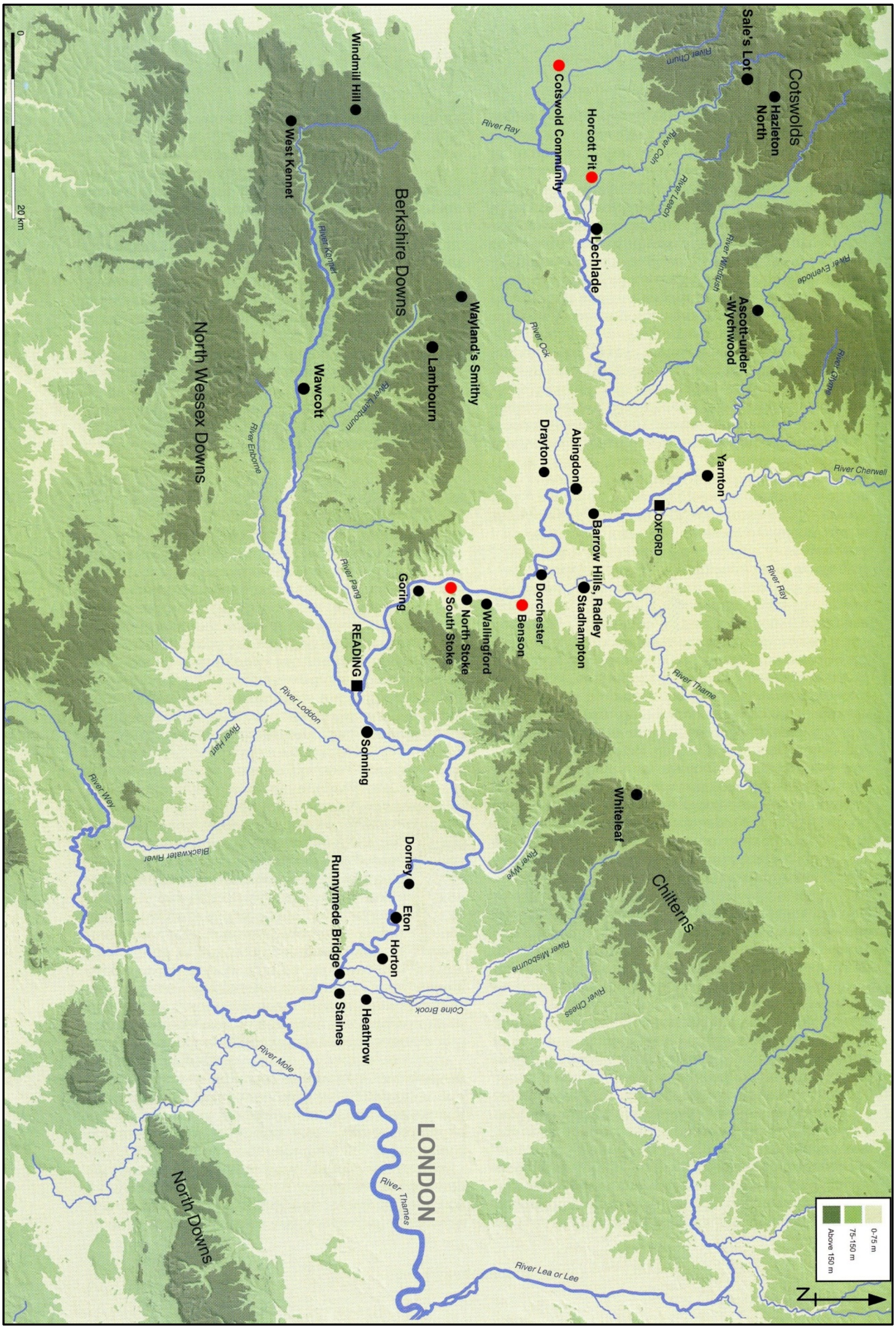


**Figure 2.1** The Thames Valley with sites mentioned in the text. The Stanwell cursus is located at Heathrow. After Robinson 2011

## 2.2 The region

### *2.2.1 Geography and bedrock*

Today, the source of the River Thames is found near Cirencester in the Cotswold region of Gloucestershire. The river then passes through Wiltshire, Oxfordshire, Berkshire, Buckinghamshire, Surrey, and Kent before it joins the North Sea at Southend, Essex. From source to sea the Thames flows for 346 kilometres, which makes it the longest river in England and the second longest in Britain. The Thames Valley contains the river basin and catchment of the Thames and all or most of its tributaries. The area between the river source in the Cotswold Hills and the chalk escarpment of south Oxfordshire is known as the Upper Thames Valley. A series of tributaries join the Thames from the Cotswolds, including the Windrush and the Evenlode. The Cotswold oolitic limestone gives way to a series of Pleistocene clay formations as the landscape flattens out into the Upper Thames Basin. This part of the Thames region is underlain by a marine deposit known as the Oxford Clay (Brown 1997: 155). In Oxfordshire the river circumvents the Corallian Ridge, a hard limestone escarpment, before it enters Oxford from the north. The point where the Thames breaks through the chalk hills of Oxfordshire and Berkshire, thus separating the Chilterns from the Berkshire Downs, is known as the Goring Gap. The Middle Thames Valley stretches from the Goring Gap to the outskirts of London, constituting the western half of the London Basin. It is bounded to the north, west, and south by the chalk hills of the Chilterns, the Berkshire Downs, and the North Downs. The Kennet and the Cole are among the main tributary rivers in this stretch of the Thames. Greater London constitutes most of the Lower Thames Valley, and the river becomes tidal at Teddington Lock in south-west London. The Lower Thames and the Thames Estuary have been subject to more severe sea-level fluctuations during the Holocene than the Upper and Middle Thames regions (Holgate 1988: 16). The Lower Thames is not included in this study as it has been differently shaped by tidal activity, sea-level change, and at least two millennia of urban development.

### *2.2.2 Superficial geology*

Further upstream, the Upper and Middle Thames regions have also been remodelled during the Holocene, but here the changes were brought about by ice as well as by sea. Only a small part of the region was covered by ice during the last glaciation, but as the ice receded

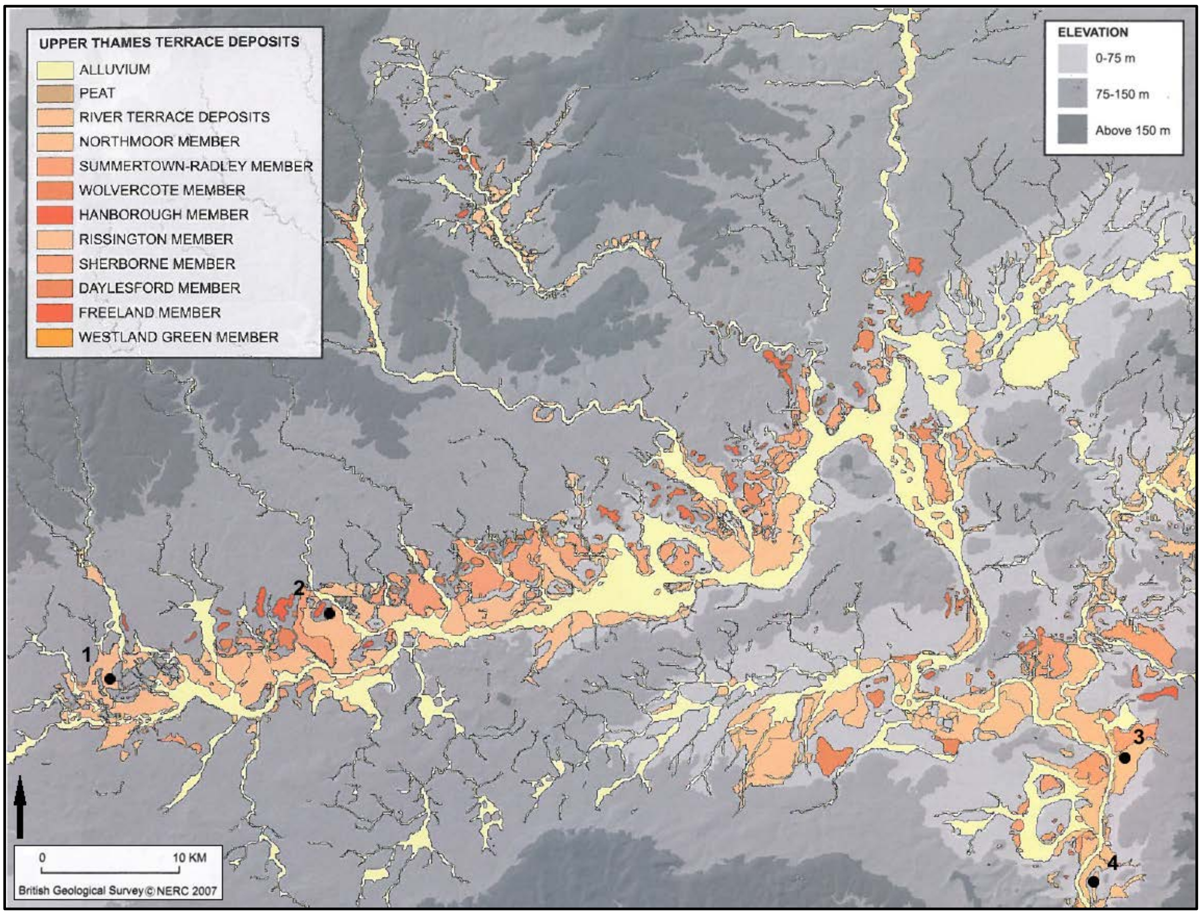


**Figure 2.2** River terrace deposits in the Upper Thames Valley. 1: Cotswold Community, 2: Horcott Pit, 3: Benson, 4: South Stoke. After Morigi et al. 2011

in adjacent areas vast quantities of meltwater transformed the valley landscape. A network of minor braided streams was at that time replaced by broader, incised channels (Robinson 1992: 198). During the Pleistocene and early Holocene, a series of sea-level falls left parts of the floodplain exposed and deepened the river bed, leaving behind the gravel terraces that are still in place along the river for most its stretch (Brown 1997: 34-36). The terrace deposits rise like a set of steps up the sides of the valley on each side of the present river (Morigi et al. 2011: 3). They are narrower in the Upper than in the Middle Thames region since the effects of sea-level change decrease with increased distance from the sea (Robinson and Lambrick 1984: 811). The character of gravel deposits varies along the course of the river according to the composition of the parent outcrop (Robinson 1992: 198). For example, the Upper Thames gravels contain limestone pebbles derived from the Cotswolds and the Corallian Ridge, in addition to the more ubiquitous flint and quartzite. The more extensive gravel terraces of the Middle Thames region are found up to 170m

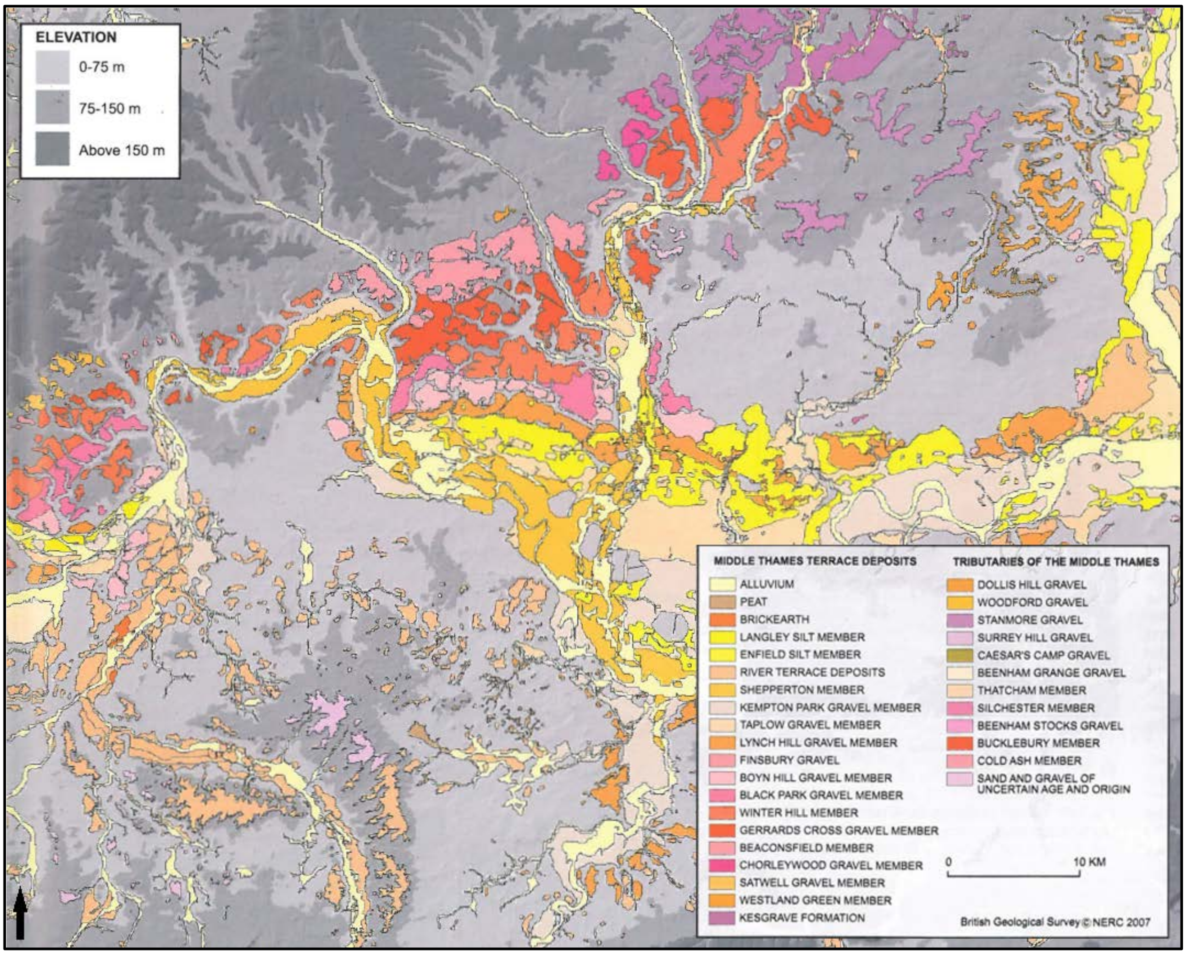


**Figure 2.3** River terrace deposits in the Middle Thames Valley. After Morigi et al. 2011

above the modern river and may be several kilometres wide (Lamdin-Whymark 2008: 7). A more recent feature of the superficial geology of the river basin is related to human occupation rather than the movements of sea and ice. Immediately along the river, layers of alluvium cover the floodplain gravel. Prehistoric remains are overlain by or interstratified with the alluvium, since much of it was laid down during and after the first millennium BC. In earlier periods extensive woodland prevented the deposition of alluvium on the riverbank, despite occasional overbank flooding. A thin, often sandy, non-alluvial layer of soil developed over the gravel in the early post-glacial period (Lambrick and Robinson 1988: 55). Sporadic episodes of forest clearance during the Neolithic in combination with the mid-Holocene Elm Decline resulted in a gradual opening of the woodland. Soil erosion accelerates and floods become more frequent when woodland is replaced by grass or ploughed land. The effects of floods on the landscape are augmented because deposits of silt, clay, and loam on the riverbank reduce its drainage capacity. Such a process was underway in the Thames Valley in later prehistory and culminated during the Late Iron

Age to Roman period, probably due to population growth and arable expansion rather than climatic change (Robinson and Lambrick 1984; Linford et al. 2005). The rate of alluviation has not been consistent along the length of the river, and deposits are generally thicker in the Middle than in the Upper Thames (Lamdin-Whymark 2008: 8). Alluvial layers in the Upper Thames region are rarely thicker than one meter (Robinson 1992: 201). The gravel 'islands' that sometimes protrude through the alluvium on the first gravel terraces are remnants of the rolling surface left by the post-glacial lattice of streams and channels (ibid. 200). These features of the Thames Valley landscape present archaeology with both possibilities and limitations.

## 2.3 History of archaeological research

Until relatively recently, the Thames Valley Neolithic was obscured by the fame of its neighbouring regions. The Cotswolds and Wessex have received more persistent archaeological attention due to the abundance of upstanding, stone-built monuments. The Thames Valley overlaps with Wessex since the Thames passes through north Wiltshire and the river Kennet is a main tributary. In addition, some of the Cotswold long barrows are found adjacent to Thames tributaries in Gloucestershire and Oxfordshire. Thus the western and southern outskirts of the Thames Valley contain the best known Neolithic remains. Eminent antiquarians John Aubrey and William Stukeley both examined the blockbuster sites of Wiltshire during the 17th and 18th centuries, and in 1812 Richard Colt Hoare published his *Ancient History of Wiltshire* (Smith and Brickley 2009: 20). Around fifty years later, the West Kennet long barrow was famously opened by John Thurnam with the help of patients from a local asylum (ibid. 24). Since then, more than half of the Wiltshire long barrows listed by Darvill (2004a: 252-253) have been excavated in some manner. In Gloucestershire, one third of ninety-nine Cotswold-Severn barrows have been investigated (ibid. 244-249). In contrast, only two long barrows in Oxfordshire were opened during the 19th century. Since Wayland's Smithy is traditionally located in Berkshire rather than Oxfordshire, Ascott-under-Wychwood is the only Oxfordshire long barrow that has been excavated in the last century (Benson and Whittle 2007).

Cropmarks of long barrows and other Neolithic monuments are known in the Thames region thanks to aerial surveys undertaken continually since the 1930s. Prehistoric remains situated on the higher gravel terraces and in the uplands are more vulnerable to weathering and erosion; the cropmark sites are often poorly preserved (Holgate 1988: 28; Allen et al. 1997: 116). In addition, they tend to be heavily ploughed and it is only under certain subsoil conditions that sites appear as cropmarks. Today, the known archaeological landscape is being extended to include remains on the floodplains. Here, our understanding of prehistoric occupation is bound up with the pace of modern settlement and industrial activity. The need for protection of archaeological remains was acknowledged long before the introduction of Planning Policy Guidance 16 in 1990. For example, Emery (1974: 33) warned that the Oxfordshire 'record is in a critical state of flux […] prehistoric sites are being obliterated by powerful agents of change in the landscape'. Holgate (ibid. 31-32) predicted that sites buried beneath alluvium would be discovered through quarrying. He was right: implementation of PPG16 helped to populate the map of Neolithic life in the Thames Valley. In the early 1990s, the rate of discovery was such that a review of archaeological remains in Oxfordshire published in the mid-1980s was in need of an extensive update only a decade later (Barclay et al. 1996: 1). Ironically, the quick rate of discovery resulted from planning policies aimed at evading archaeological remains (Lambrick 1992: 211). Gravel extraction industries abandoned the higher terraces and moved onto the floodplains, partly in order to mitigate the threats posed to known archaeological sites on the higher gravel terraces. The recently discovered remains include many floodplain sites that had been sealed by alluvium. The most reliable way of identifying such remains is trenching (ibid.). Aerial photography, fieldwalking, and geophysical survey are unrewarding in these 'archaeologically invisible areas' (Allen et al. 1997: 117). Unsurprisingly, the two most prominent non-monumental Neolithic sites – Yarnton in Oxfordshire and Eton Rowing Course at Dorney in Buckinghamshire – initially attracted archaeological attention because of adjacent cropmarks on the higher terraces (ibid. 120). The fact that trenching is the best, if not the only, way to detect sites buried beneath alluvium makes assessment and development of appropriate sampling strategies extremely difficult. It also has implications for management and protection since the lack of non-intrusive means of establishing genuine absence of archaeology poses questions about what constitutes a 'site' (ibid.; Bell 1992: 275). This is a very real concern as gravel extraction in the vicinity of archaeological remains can cause dewatering and deterioration of preservational conditions (Lambrick 1992: 217). The water table was lower in the Neolithic and Early Bronze Age. Later rise of the groundwater level, along with alluviation, have helped to preserve prehistoric remains (Allen et al. 1997: 117-120). Their recovery, where possible, enables us to piece together a more detailed account of the fourth millennium BC.

## 2.4 The late fifth and earliest fourth millennia BC

### *2.4.1 The inherited landscape*

Our understanding of Holocene environmental history of the Thames Valley is based on a handful of well-investigated locations. It relies on pollen sequences, macroscopic plant remains, and mollusc shells, most of which has been recovered from waterlogged palaeochannel sediments (Lambrick and Robinson 1988: 62; Parker and Robinson 2003: 43). Radiocarbon-dated pollen sequences from two locations in the Oxford region provide an outline of post-glacial vegetation change in this part of the Upper Thames region (Day 1991). By the late Mesolithic, a sparse tree cover of birch, pine, and willow had been replaced by denser, canopy-forming woodland. In the early fourth millennium BC, lime dominated forests on drier soils and alder was abundant in moister areas (ibid. 465). In the Middle Thames, detailed sequences are available from Dorney in Buckinghamshire (Parker and Robinson 2003) and Runnymede Bridge in Surrey (Needham 1992, 2000). Early Holocene woodland expansion similar to that in the Upper Thames is evident: larger species such as elm and oak succeeded the post-glacial tree cover of birch, pine, and hazel during the ninth millennium BC. Wetland plants may have been more abundant along the river margins in the Middle Thames than further upstream. Deliberate burning of reedbed vegetation during the Early Mesolithic is indicated in the Dorney area (Parker and Robinson 2003: 55). By 4000 BC, carr woodland dominated by alder had replaced the wetlands. The course of the Thames and its tributaries had by this time become established, and smaller waterways were beginning to silt up. Downstream, the London area may not have been inhabitable in the Early Neolithic due to the extent of marshland (Wilkinson and Sidell 2007).

The Mesolithic is elusive in the material record across Britain and the Thames Valley is no exception (Hey and Robinson 2011b: 221). We have seen that new information about the fourth millennium BC has come to light thanks to a few extensive excavations and numerous smaller-scale investigations carried out in the region in the last twenty years. In comparison, our understanding of the Thames Valley in the fifth millennium BC has not been greatly advanced (Hey and Barclay 2007: 399). However, fresh data from fieldwork or scientific discovery does not necessarily top the wish list of British Mesolithic scholars. Instead, a growing body of research explores the premise that the nature of the archaeological record is 'representative of the real world of the Mesolithic' (Finlayson 2006: 166). Diverse and dynamic Mesolithic societies emerge when more 'intimate' approaches are applied (ibid. 167-168). Both regional and temporal changes during the six millennia of the Mesolithic are evident in the region, although inhabitation in the Middle Thames is better attested than in the Upper Thames. A majority of the 35 radiocarbon dates relating to the period has been obtained on material from the Kennet Valley (Hey and Robinson 2011a: 193). Sites are often located near one of the waterways, and Late Mesolithic sites significantly outnumber earlier ones (ibid. 196, 208). Several Neolithic sites throughout the region have produced some evidence of Late Mesolithic activity – examples include South Stoke, Eton Rowing Course, and the Staines causewayed enclosure. However, in the area just beyond the Goring Gap in the Middle Thames, the extent of occupation may have declined in the Late Mesolithic (Hey and Robinson 2011a: 210). Not all known sites represent short-lived episodes of occupation; hollows and tree-throw holes with associated postholes may be interpreted as longer-term shelters (ibid. 215). Such features are known at Wawcott in the Kennet Valley. Recent research suggests that the traditional view of a more persistently occupied valley floor complemented by short-lived hunting stations in the uplands is simplistic (ibid. 211). Lamdin-Whymark (2008: 186) argues that the evidence from a region such as the Middle Thames catchment does not represent Mesolithic mobility patterns in their entirety. Instead, the area may have been part of a much larger inhabited landscape. Inhabitation during the late fifth millennium is poorly dated, although radiocarbon dates that surround the transition from the fifth to the fourth millennium have been obtained from beneath the Ascott-under-Wychwood long barrow, at Wawcott, Staines, and Daisy Banks near Abingdon (Hey and Barclay 2007: 400). At this time, we may envisage a population of around one thousand individuals in the Thames region (Hey and Robinson 2011a: 193).

### *2.4.2 The turn of millennia*

The appearance of 'definably Neolithic activity' in the Upper Thames region probably predates that in the Middle Thames by about half a century (Bayliss et al. 2011: 727-729). However, Greater London, the Weald, Kent, and the Cotswolds have all produced even earlier date ranges. Such activity in the Greater London and Kent region is likely to date to the final century of the fifth millennium BC. The Neolithic as we know it does not appear synchronously across southern Britain, and the pace of change during the centuries that follow is not consistent (ibid. 800). The modelling of radiocarbon dates for the earliest diagnostic Neolithic in south England was based on assemblages that contained polished stone axes, Bowl pottery, and leaf-shaped arrowheads (ibid. 730). In addition to material culture, domestic food species and more permanent architecture were considered to herald a Neolithic presence. However, not all features of the Neolithic can be closely dated through application of Bayesian statistical modelling onto radiocarbon date ranges. The technique relies on identification of an end as well as a beginning of the archaeological phenomenon in question. This can be achieved with, for example, causewayed enclosures or specific pottery styles. In the case of domestic food species, however, such end points cannot be defined since they feature in the archaeological record for the remainder of prehistory (ibid. 729).

In terms of their content, Mesolithic- and Neolithic-style artefact assemblages are not generally perceived as overlapping. In other words, Mesolithic material culture is not found intermingled with Neolithic-style repertoires. Anticipation of such ‘transitional’ assemblages may not be misguided, taking into account the continuity seen in site distribution and character across the transition from the fifth to the early fourth millennia in some parts of the region. Indeed, some features of the material record also appear to transcend the transition. The main component that Mesolithic and Neolithic sites have in common is wild plant foods, primarily hazelnuts. Microliths disappear from the record in the late fifth millennium BC, but other Mesolithic-type elements of the flint tool repertoire, such as burins and serrated flakes, persist well into the Neolithic (Lamdin-Whymark 2008: 13). Polished or ground stone axes – the original symbol of the Neolithic – were produced in south Wales during the Mesolithic (David and Walker 2004). Beads made of shell have been found at Mesolithic sites in the region (Hey and Robinson 2011a: 215). In the Early Neolithic, beads were made of bone, shale, shell, stone, and clay – two examples of the latter were found during excavations at the Ascott-under-Wychwood long barrow (Barclay and Case 2007: 281). Other features, such as pottery, seem exclusively Neolithic.

In our region, the appearance of pottery, polished stone axes, and domestic food species in the early fourth millennium BC is not matched in the record by large-scale reorientation of settlement patterns. Accumulation of material culture debris in middens and use of tree-throw holes are in evidence during the final centuries of the Mesolithic as well as in the first quarter of the fourth millennium (Hey and Barclay 2007: 416; Lamdin-Whymark 2008: 207). As in the Neolithic, Mesolithic occupation may have centred on small cleared areas in the woodland (Hey and Barclay 2007: 403). In the Cotswolds and Upper Thames, core areas of incipient Neolithic activity are found adjacent to Late Mesolithic occupation areas (Barclay 2007a: 337). Nonetheless, here and in the Kennet Valley the transition to the Neolithic may have involved a 'shift in territory' (ibid.; Whittle 1997). Neolithic lifestyles would have placed different kinds of temporal and spatial demands on people and environment, and this may be seen in the longevity of occupation at certain places (Lamdin-Whymark 2008: 207).

The pollen sequence from Daisy Banks Fen near Abingdon in Oxfordshire shows a significant increase in cereal pollen, coinciding with the Elm Decline, during the final centuries of the fifth millennium and first quarter of the fourth (Robinson 2011: 182). However, it is possible that wheat or barley was grown in the vicinity and entered the environmental sample as processing waste (ibid.). No indications of widespread woodland clearance dating to the early fourth millennium BC were found at Eton Rowing Course in Dorney or at Runnymede, even though the sequence from the latter site show some human impact that pre-date the Neolithic (Hey and Barclay 2007: 403). During the first half of the fourth millennium, the extent of woodland clearings varied along the river. The clearings do not appear to have been maintained for long periods of time; indications of woodland regeneration are frequent in the environmental record. The picture is one of many small and shifting openings in the forested landscape (ibid. 404). Incoming groups may have encountered and occupied forest clearings without markedly impacting upon the lives of hunter-gatherer groups that were already living in the wider landscape (ibid. 416). Thus Emery (1974: 36) may have underestimated the extent of activity of indigenous inhabitants when he remarked that '[i]gnorant of metal though they were, it is to these versatile Neolithic immigrants from the west that we must attribute the initial momentum in landscape-making at the hands of men'. Whittle (2007: 391) envisages a 'small-scale, filtered colonisation' that was underway alongside change among native hunter-gatherers. Similarly, Cleal (2004: 181) suggests that the first couple of centuries of the fourth millennium BC may be thought of as a 'contact Neolithic'. Some Mesolithic and Neolithic-style assemblages may in fact be contemporaneous, even though the former is likely to be typologically assigned to the late fifth millennium. As time progressed, the new conditions that emerged through interaction between newcomers and natives began to leave a more conspicuous mark in the archaeological record.

### *2.4.3 Life and death*

Material from the midden deposit found beneath the Ascott-under-Wychwood long barrow has yielded the earliest Neolithic dates in the Thames Valley, namely around 3900 BC (Hey and Hayden 2011: 171). Slightly later dates, beginning at 3800 BC, are associated with the construction and use of this monument and the main phases at the Lambourn and Wayland's Smithy long barrows (ibid.; Benson and Whittle 2007; Schulting 2000; Whittle et al. 2007). Early stone-built monuments like portal dolmens are not known in the Middle Thames Valley, although to an extent this may reflect lack of naturally occurring stone (Lamdin-Whymark 2008: 207). The possibility that less durable monuments were built here cannot be ruled out (ibid.). In the Upper and especially the Middle Thames region, a significant portion of human remains may have been entrusted to the Thames or one of its tributaries. However, together with the Upper Kennet region, the Upper Thames Valley contains some unusual Early Neolithic single inhumation graves, primarly at Radley in Oxfordshire (Garwood and Barclay 2011). The dating of these remains is uncertain, and the majority may belong in the Middle Neolithic period. Only five Neolithic monuments in the Middle Thames, including the Staines causewayed enclosure and the Whiteleaf barrow, have yielded human skeletal material (Lamdin-Whymark 2008:191). The monuments also impact on the lives of the living, as the appearance of monuments was accompanied by changes in the degree of mobility and economic practices (Lamdin-Whymark 2008: 208). At Hazleton North, the midden beneath the barrow was ploughed, perhaps as part of a larger cultivation plot. Thus some of the clearings that were created in the dense woodland were made to accommodate dwellings and crop cultivation. The timber felled was used to build mortuary structures and track ways, as well as houses, in this period (Barclay 2007a: 335).

Traces of rectangular buildings have been found beneath some long barrows, as at Hazleton North, Ascott-under-Wychwood, and Sale's Lot in the Cotswolds (Hey and Robinson 2011b: 227). A few long houses, dating to around 3800 BC, have been found on their own in the region (Barclay 2007a: 335). Notable examples include the houses at Yarnton in Oxfordshire and Kingmead Quarry at Horton in Berkshire. At Yarnton, finds associated with the building were scarce apart from a collection of cremated human and pig bone that had been used as packing to support one of the timber posts (Hey and Robinson 2011b: 231). Burnt clay was found in a few postholes, indicating that the walls were covered with wattle-and-daub (ibid. 234). At Horton, four houses dating to c. 3800-3640 BC have been found during sand and gravel extraction (Nichols 2013). The houses make this site as yet unparalleled in Britain. At present, this site compares better with the Irish Neolithic, which contains more than 80 timber houses distributed across 52 sites (Smyth 2013: 303). Two of the Horton structures were built using planks, whereas the other two and the house at Yarnton were constructed of timber posts. The Horton houses post-date the Yarnton structure by at least half a century. The wall footings of one of the plant-built houses at Horton yielded a wider range of finds, and the material culture fragments, charred hazelnuts, cereal grains, and animal bone suggest that the floor was kept clean (Hey and Robinson 2011b: 231). These buildings may have been permanently settled or they may have been visited at intervals, perhaps by a larger group. In any case, they would not have been in use for extended periods of time, and they are still rare in the British Neolithic record. At the end of the first quarter of the fourth millennium, the rate of change accelerated (Bayliss et al. 2011: 801), and we begin to see more features that are strongly associated with the Early Neolithic.

## 2.5 Early Neolithic prime time

### *2.5.1 Causewayed enclosures*

The three to four centuries that surround the mid-fourth millennium BC represent the height of the Early Neolithic, although several changes occur within this period (Barclay 2007a: 332). This portion of the millennium is characterised by the construction of causewayed enclosures, initially around 3750 BC in the Thames Estuary and Kent (Whittle et al. 2011b: 897). A century later several enclosures had been created in East Anglia, on the south coast, and in Wessex. In our region they appear slightly later, just after 3650 BC (ibid.). Causewayed enclosures do not cluster as much as the burial monuments of the earliest Neolithic in the Thames catchment (Hey and Barclay 2011: 261). Nonetheless, their distribution reflects the significance of lowlands and waterways – while most enclosures of Wessex are found in upland locations, in the Thames Valley they tend to be

**Figure 2.4** Early Neolithic funerary monuments and enclosures in the Upper and Middle Thames. From Garwood et al. 2011

located within a couple of kilometres of one of the rivers (Oswald et al. 2001). At least eighteen causewayed enclosures are known the Thames and Kennet catchment, the majority of which have not been excavated (Hey and Barclay 2011: 285). Windmill Hill in Wiltshire and Staines in Surrey are the best studied, followed by Abingdon (ibid.; Whittle et al. 1999; Robertson-Mackay 1987; Avery 1982). The latter may be an example of an isolated enclosure, while in other parts of the region they cluster in groups of three to five (Hey and Barclay 2011: 285). When recognised in the first half of the 20th century, they were interpreted as permanently occupied settlements. I return to the interpretation of causewayed enclosures in the next chapter, as it has had implications for our understanding of the ceramics of this period. Suffice to say here that by the 1990s, the notion of causewayed enclosures as settlements had been challenged (Oswald et al. 2001; Bradley 2007: 71). The currently dominant notion of Neolithic life as more mobile than previously thought implies that causewayed enclosures fulfilled more complex and varied roles.

### *2.5.2 The inhabited landscape*

The recovery of middens and pits by modern standards of excavation provides important information about life beyond the monuments. In addition to the midden material that is sometimes found beneath long barrows and cairns, isolated middens have recently come to light. In this period, remains from the Middle Thames catchment constitute some of the best known settlement evidence from the wider region (Ford and Taylor 2004: 99). Excavations at Eton Rowing Course in the Dorney area of Buckinghamshire revealed two middens in the main study area and one in its vicinity, all sealed by alluvial deposits and located within three kilometres of one another. The most substantial midden was up to 80 metres long (Hey and Robinson 2011b: 239). A midden is characterised by dark, charcoal-rich soils containing material culture debris and fragments of bone and plants (ibid. 236). Apart from the more ubiquitous flint and pottery, the middens at Dorney yielded quernstones, pounders, fragments of fired clay, parts of an antler mattock, and a bone awl (Allen et al. 2004: 89). The excavations also uncovered other types of remains, including accumulations of material in palaeochannels and tree-throw holes, pits, flat graves, and specialised activity areas (ibid. 84). No structural remains were found, despite concerted efforts to locate such remains. The earliest radiocarbon dates from the site cluster around 3900 BC, although some Mesolithic microliths were also recovered. Occupation then lasted throughout the Neolithic and into the Bronze Age, but the scale of activity probably diminished in the Late Neolithic (ibid. 97). No evidence for permanent settlement was found. Instead, the wealth of remains at this locale, adjacent to the river between Maidenhead and Windsor in the Middle Thames Valley, probably results from repeated visits. This is reflected in, for example, the stratigraphy and condition of midden material. Such indications of distinct but recurring visits are found at other known sites with middens across the region, from the Cotswolds to the Kennet Valley and Runnymede in Surrey. At the latter site, midden deposits were recovered in association with hearths. Notably, at Eton Rowing Course and Hazleton North some of the material from within the middens appears to have been brought from elsewhere (Hey and Robinson 2011b: 239).

The more substantial middens probably represent instances where accumulation continued, perhaps for several centuries, instead of being abandoned or sealed by a structure or monument. By 3700 BC, material culture was increasingly placed in cut features such as pits and enclosure ditches rather than middens and tree-throws (Lamdin-Whymark 2008: 208).

We have seen that the remains of an Early Neolithic house were recovered at the multi-period site of Yarnton Floodplain in the Upper Thames. The site is located five kilometres north of Oxford, between the villages of Yarnton and Cassington in Oxfordshire. It was discovered as a result of gravel extraction in the late 1980s, and a series of excavations were undertaken during 1990s. The majority of known archaeological remains are located on the floodplain, and a smaller proportion of features have been found on the second gravel terrace (Hey and Bell 2000: 2). Many of the features were situated on gravel islands bounded by palaeochannels. Traces of causeways that connected the living areas during the earliest phases of occupation, when water was flowing through the channels, have been found (ibid. 9). Prehistoric living surfaces were generally not preserved due to Roman-period agricultural activity, although many undisturbed cut features such as postholes and pits could be recovered. Alluvial deposits that post-date the Roman period are more extensive, and damage by modern agriculture is minor (ibid. 8). Remains dating to the Neolithic, Bronze Age, Iron Age, Roman and Saxon periods were found. Features were generally found in clusters rather than interstratified, thus enhancing their contextual integrity (ibid.). It is this longevity of occupation and the well-preserved and diverse traces thereof that make this site so significant. Some components of the site are rare – in addition to the house, a Neolithic U-shaped enclosure and in-situ artefact spreads were found (Hey and Barclay 2011: 278). Other features, including the clusters of pits, are more common. Given that the site at Yarnton is scattered with remains from different periods, its character as a ‘pit site’ at some point in the Neolithic may be obscured. Artefact and ecofact assemblages were generally well preserved, although water table fluctuations have impacted on the material in most areas. Remarkably, few small pieces of charred barley bread, dating to the mid-fourth millennium BC, were found in one of the Yarnton pits (Hey and Barclay 2011: 247). Alternatively, the pieces are the remains of burnt porridge.

Runnymede on the bank of the Thames is one of the best known Early Neolithic sites in the region (Needham 1992). The site, located less than one kilometre from the Staines causewayed enclosure, produced a wealth of evidence for economic practices and circumstances of deposition thanks to good preservational conditions and high standards of recovery. The Neolithic phase of occupation may have lasted up to 500 years but was abandoned in the early third millennium, probably due to flooding of the floodplain. In two respects, the evidence from Runnymede is atypical of Early to Middle Neolithic remains in the region. First, the pottery assemblage comprises an uncharacteristically high proportion of decorated vessels (Barclay 2002: 88). Second, in some parts of the site the faunal remains are not dominated by cattle. Instead, pig and cattle appear to be equally represented (Serjeantson 2006). In addition to domestic species, remains of wild animals such as red deer, roe deer, badger, fox, and polecat were present along with wild varieties of cattle and pig (ibid. 120). Wild plants growing along the damp river margins appear to have been utilised, while cereal cultivation played a minor role (ibid. 121). Towards the mid-fourth millennium BC, arboreal pollen decreases and gives way to pollen of herbaceous species in both the Upper and Middle Thames. In this period, woodland was cleared on the gravel terraces on a larger scale than previously (Barclay 2007a: 332), although grassland expansion may not have been as extensive here as in parts of Wessex (Thomas 1999: 184). In most cases the clearings were eventually abandoned, as seen in the evidence for woodland regeneration (Robinson 2011: 183). At any given time, clearances would have been ‘arranged like a string of beads along the river Thames’ (Thomas 1999: 184). Trees need not have been felled using axes, since at Drayton in the Upper Thames Valley there are indications that substantial trees were upended with their roots, creating large depressions in the ground (ibid. 182; Barclay et al. 2003). This probably took place towards the end of the Early Neolithic and may have been associated with construction of the Drayton cursus.

## 2.6 The Middle Neolithic

### *2.6.1 The incised landscape*

The Middle Neolithic ‘begins’ around 3300 BC. These final three centuries of the fourth millennium BC comprise both continuity and contrasts with preceding centuries. Waterways maintain their role as significant receptors of cultural material, and pit digging and deposition appear to accelerate (Lamdin-Whymark 2008: 189). Both isolated pits and small pit clusters were dug in this period, and their contents may have been more ‘selectively derived’ from pre-pit contexts than in earlier periods (ibid.). In addition to elaboration of earlier practices and material culture repertoires, new kinds of monuments begin to be built. In the 1930s, aerial photographic surveys started to reveal the extent of cursus monuments on the gravel terraces of the Thames and its tributaries (Hey and Barclay 2011: 293). At least a dozen cursus monuments and/or long enclosures have been identified in the region as a whole, although the majority are found in the Upper Thames. Cursus monuments are found throughout most of the British Isles, and those in the Drayton and Dorchester area of the Upper Thames are the densest known concentration (ibid.; Barclay et al. 2003: 234). Increased interest in landscape archaeologies in the last couple of decades has benefitted the study of these cryptic monuments. Cursus ditches have been subject to more excavation than exterior and interior areas, but unlike the earlier causewayed enclosures they tend to yield few artefacts (ibid. 235). The scarcity of finds from cursus monuments has impeded understanding of the chronologies involved, and the latter half of the fourth millennium is not as well dated as the earlier part of the period. Moreover, a plateau in radiocarbon calibration curves in the period 3350-3000 BC makes it difficult to hone in on specific developments or types of remains. Consequently, the relationship between mortuary monuments such as bank barrows, oval barrows, and U-shaped and long enclosures is not clear. The latter types of monuments may have evolved into the more extreme forms of elongated enclosures that we recognise as cursus monuments. Alternatively, they are largely contemporary and possibly complementary. Given the absence of human remains at cursus monuments, the latter scenario is the more convincing (Barclay and Bayliss 1999). In this respect, the early date of somewhere in the 36$^{th}$ to 35$^{th}$ centuries BC obtained for the construction of the Drayton cursus is interesting (Barclay et al. 2003: 95). At Drayton, the immediate landscape is littered with artefact scatters and monuments, including barrows and enclosures. However, the majority of monuments postdate the cursus (ibid. 100). Similarly, the cursus at Dorchester-on-Thames predates most other monuments in the vicinity, and the cursus may in fact have had ‘the power to attract’ later projects such as henges and burials (Loveday 1999: 55). That is not to say, however, that cursus monuments did not intersect other, less conspicuous features of the inhabited landscape, such as paths (Barclay et al. 2003: 237).

The function(s) of these monuments remains unknown, although many interpretations favour scenarios of pilgrimage and ceremonial processions (e.g. Harding 1999; Johnston 1999). There is reason to suspect that the interiors would have been accessible via causeways across the flanking ditches (Barclay et al. 2003: 219). In addition to Drayton and Dorchester-on-Thames, well-known cursus monuments of the Upper Thames region include those at Stadhampton and Lechlade (ibid. 216). As we have seen, earlier monuments were often located near one of the rivers. The preference for riverside locations is even stronger with cursus monuments, and some of them align with the course of the river (ibid. 219). In the Middle to Lower Thames, the Stanwell cursus was discovered during excavations at Heathrow Terminal 5 in the 1990s (Framework Archaeology 2010). Another probable smaller cursus has been recorded as cropmarks at Sonning in Berkshire. The latter half of the fourth millennium may be characterised by 'an increased interest in the opening up of the earth' (Thomas 1999: 69). At times these cut features received the remains of the dead. During the final quarter of the millennium, the disarticulated human remains of earlier tombs are replaced by articulated burials in flat graves and ditches (Lamdin-Whymark 2008: 195-6). Such burials have been found at Yarnton and at Barrow Hills near Radley in Oxfordshire. The latter site also comprised a Middle Neolithic oval barrow (Barclay and Halpin 1999).

### *2.6.2 People and animals*

The practice of single inhumation burials seen at Radley and Mount Farm in the Early Neolithic continues into the Middle Neolithic. The pre-Beaker phase at Radley in Oxfordshire comprises six burials, including both articulated and disarticulated remains. The chronology is not straightforward and long date-ranges make it precarious to distinguish Early from Middle Neolithic remains, but at least two females are buried in the latter period. One is an elderly woman whose remains are disarticulated and the other is an adult who was buried with a flint knife and jet belt slider (Garwood and Barclay 2011: 390; Bradley 1992). These burials belong to a small but unusual group of 'complex' burials of Middle to Late Neolithic date in the Upper Thames region (Garwood and Barclay 2011: 395). They are pit burials covered by a mound and associated with lithic artefacts as grave goods. Each site has yielded the remains of an adult female, only in Grave 2126 at Radley is she accompanied by an adult male. In addition to Radley, such burials are known at Stanton Harcourt, Newnham Warren, and Mount Farm, although the latter site may significantly predate the others. Ambiguous radiocarbon evidence precludes detailed assessment, but if they do belong in the final centuries of the fourth millennium BC they may represent a single inhumation tradition that replaced the earlier communal burials (ibid. 398). In the Middle Thames, two inhumation graves of one child and one male adult have been found at Eton Rowing Course and dated to the Middle Neolithic (ibid.; Allen 2000). Unlike the burials in the Upper Thames, these burials were not associed with lithic artefacts. Inhumation burial was not the only way of disposing the dead in this period. Small quantities of cremated and charred human remains have been found in many Early as well as Middle Neolithic contexts (ibid. 399). For example, the cremated remains of an adult female were found in the top layer of one of the pits associated with the house at Yarnton. Small deposits of cremated bone as secondary contexts in Early Neolithic monuments are also common. The earliest known cremation cemetery in the Thames Valley was uncovered during excavations at the Imperial College Sports Ground in Colne Valley, Greater London, and dated to c. 3200-3900 BC. Here, at least six individuals were buried, including both children and adults (ibid.).

Economic arrangements also changed towards the late fourth millennium BC. The scale and significance of cereal cultivation decreased in the Thames region during the latter half of the millennium and subsistence practices became increasingly centred on animal husbandry (e.g. Barclay 2007a: 332), although Thomas (1999: 69-70) has argued that there is little support for such a ‘prosaic’ scenario of subsistence change towards the end of the fourth millennium BC. Nonetheless, the increased frequency of isolated pits indicates that the degree long-lasting, recurring occupation at a few specific places in the landscape subsided. Instead, social fragmentation and increased mobility, perhaps related to cattle husbandry, may explain some of the features of the late fourth millennium record (Lamdin-Whymark 2008: 189). However, the preference for beef and milk in the later fourth millennium must be considered against the dominance of pig in faunal assemblages of the third millennium (e.g. Albarella and Serjeantson 2002). In other words, a largely pastoral economy centred on cattle may be an appropriate economic framework for the Middle Neolithic, but it did not last. Foodways and settlement patterns continued to fluctuate. What is more, cattle husbandry may not have been engaged in equally in all regions of Britain. Some of the questions that arise from these issues may be addressed through the organic record. Dairy foods may have been consumed more routinely than meat by pastoral groups. Presently, however, information obtained through analysis of absorbed organic residues in pottery suggests that dairy foods were produced from the onset of the Early Neolithic (e.g. Copley et al. 2005). I return to this in later chapters.

## 2.7 Pits

### *2.7.1 Histories*

The practices of pit digging and deposition emerged in the Early Neolithic, possibly through Late Mesolithic/Early Neolithic activities in and around tree-throw holes (Lamdin-Whymark 2008). The significance of tree-throws appears to peak around 3700 BC, and this coincides with an increase in the rate of pit digging. The tradition of pit digging and deposition then persisted for more than 2000 years, into the Early Bronze Age (Thomas 1999; Anderson-Whymark 2012). Some recognition of this remarkably long-lived phenomenon goes back a century or more – references to pits in early archaeological accounts are not uncommon (Anderson-Whymark 2012: 187). By the mid-twentieth century, the recovery of LBK longhouses in Continental Europe influenced British archaeologists to look for parallels at home (Garrow 2006b: 4). The search led Grahame Clark, Christopher Hawkes, and others to highlight the scarcity of British Neolithic settlement evidence (ibid.). The non-monumental evidence that was subsequently discussed included pits, both in association with other kinds of remains and on their own. When Hurst Fen was excavated in Suffolk in the 1950s, it was the first archaeological site that was dominated by pit features (Clark 1960; Garrow 2006b: 5). Clark and colleagues suggested that these were storage pits, since they contained worked flint, pottery, and organic remains. In the 1980s and 90s, pits were studied in more detail due to increased emphasis on depositional practices (Garrow 2006b: chapter 2). Deposition of cultural material in the ditches of causewayed enclosures and long barrows, in pits, and in the postholes of henge monuments was scrutinized (e.g. Cleal 1984; Richards and Thomas 1984; Thomas 1991, 1996b; Pollard 1995). In this context, Thomas (1991, 1999) compared the Neolithic/Bronze Age pits with those found on Iron Age sites. He (1999: 64) separated what he saw as two distinct pit-traditions; the Iron Age storage pits belonged to a different set of activities and had different purposes than the earlier pits. Thomas thereby discredited previous accounts in which virtually all prehistoric pits were dug for storage purposes. Instead, he emphasized the act of deposition of material culture. In his view the deposition of domestic debris into pits was a complex affair in the Neolithic, and this complexity – expressed in the formality of deposition and spatial arrangements – increased towards the end of the period (ibid.; Lamdin-Whymark 2008). This interpretation is widely accepted, and Neolithic pits are no longer considered to have been dug for storage.

Two other developments have contributed to the increasing archaeological engagement with evidence from pits. First, they have been found in large numbers across Britain since the establishment of PPG16 in 1990. Today, they are among the most common types of Neolithic features. Second, as we saw in the previous chapter, the idea of a settled Neolithic has been questioned. Thomas (1996a) and Bradley (2003) have both discussed the search for Neolithic houses in terms of 'expectations'. Structural, domestic remains are scarce in the Neolithic record and it is unclear whether absence of evidence is, in this case, evidence of absence (Thomas 1996; Darvill 1996). We have seen that the British Neolithic is not a coherent package of traits that depend on one another. In other words, the presence of, for example, charred cereal grains and pottery does not equal settled, fully agricultural communities. Thomas (1996a: 1) points out that the ability to build houses does not necessarily foster a desire to do so. Instead, a range of possible scenarios have been considered (e.g. Whittle 1997; Pollard 1999). Semi-sedentary or transhumant settlement patterns feature in these narratives, and such arrangements are increasingly plausible as more evidence comes to light. Pits are an important component of such narratives. The substantial number of recently excavated pit sites has also motivated a series of regional studies of pit deposition, including those of East Anglia (Garrow 2006b), Northumberland (Edwards 2012), and Yorkshire (Carver 2012). This work corresponds with a wider focus on regional histories (e.g. Brophy & Barclay 2009), which in turn was motivated by the rejection of large-scale consistency in the British Neolithic.

### *2.7.2 Content and deposition*

Pits are not simply poor substitutes for houses, but provide important evidence in their own right. In 1910, Reginald Smith emphasized their value as containing sealed assemblages within which typological associations may be identified (Thomas 2012: 1). The recent studies have illustrated that pits do indeed represent temporally well-defined events. Despite the tight temporalities of pit deposits, they sometimes contain substantial artefact and ecofact assemblages. Cultural material is generally found jumbled within soil deposits that are darker than the surrounding soil. Remains of food processing and consumption are generally represented in such deposits. Hazelnut fragments constitute the most common type of plant, but other wild species, such as sloe and crab apple, are frequently found. Charred grains of barley and/or wheat are present in small quantities. Pit deposits containing human bone fragments are also known (Thomas 1999: 68). Flint is often present, both as knapping debitage and broken tools. In rare cases, complete objects were deposited – examples include flint knives and polished flint axes (Hey and Robinson 2011b: 243). Whole pots are rare, and sherds do not generally represent complete vessels. Sherds are sometimes recovered in varying states of preservation, indicating that they were subject to different post-breakage processes. This line of enquiry was pursued at Kilverstone in Norfolk, where 236 Early Neolithic pits were found in a series of clusters (Garrow 2006a). Post-excavation analysis of the flint and pottery assemblages showed that the condition of sherds could vary also when they derived from the same vessel (Knight 2006: 31). For example, un-weathered sherds with fresh fractures could sometimes be refitted with burnt sherds with worn fractures and surfaces. This indicates that some, but not all, domestic debris accumulated on the ground for some time before being deposited into one or several pits. Moreover, the contextual analysis revealed that each cluster of pits contained its own artefact assemblage. In other words, pottery sherds from different pits within the *same* cluster could be refitted, but no refits were identified between *different* clusters of pits. This led the excavators to suggest that the different clusters were temporally distinct (Garrow 2006a). In light of semi-sedentary settlement patterns of the period, it is likely that each pit cluster represents one distinct episode of occupation. The pit site was a place to which people returned, perhaps seasonally. The duration of each visit and the time between visits has been discussed, with suggestions ranging from a few weeks (Garrow 2006a: 77) to several months (Hey and Robinson 2011b: 245). Monuments like causewayed enclosures may have been another element of the seasonal orbit. Sofranoff's (1976) petrographic study of ceramics from monuments and 'open sites' with pit features in Wessex shed some light on the relationship between different places; she demonstrated that pottery from domestic sites was made from locally available clays and inclusions, while the causewayed enclosure assemblages comprised a wider range of fabrics. This suggests that the pit site assemblages represent ceramic repertoires made and used by a single group of people. Petrographic study of the pottery from Kilverstone supports this scenario (Sibbesson 2012).

**Figure 2.5** One of the Neolithic pits at Kilverstone during excavation. © CAU

Kilverstone is exceptional in that such a large number of pits were found. Nonetheless, the narrative put forward for the site has set the tone for interpretations of pit sites in East Anglia and beyond. In the Thames catchment and Kennet Valley, hundreds of Neolithic and Bronze Age pits have been encountered during developer-funded fieldwork in the last two decades (Hey and Robinson 2011b: 241; Anderson-Whymark 2012). Middle and Late Neolithic pits outnumber Early Neolithic ones, and pits that contain Grooved Ware pottery are the most common (Thomas 1999: 69). They are often found in clusters or pairs although isolated features are also known, as at Wallingford in Oxfordshire (Richmond 2005). Many sites are made up entirely of pits, while others have additional features such as gullies, graves, and middens as well. For example, pits were encountered along with the other remains at Yarnton, Eton Rowing Course, and Horton. Excavations at monuments also tend to uncover pit features, even though they may not be contemporary. Sites comprising clusters of pits are not as common in the Thames Valley as in East Anglia. In our region, Horcott Pit and St Helen’s Avenue in Benson are the only known examples of multiple pit clusters occurring alongside one another (Hey and Robinson 2011b: 242). Pit deposits often appear to have been scooped up, possibly from a midden-type accumulation nearby. Deliberately placed objects are the exception, but examples include pits in which large pottery sherds have been arranged as if to line the pit, with decorated exterior surfaces facing outward (ibid. 243). Pottery types are not equally represented in pit deposits. In the Peterborough tradition, the Mortlake and Fengate substyles are most commonly found in pits. A recent example includes the substantial number of Mortlake pits found at Imperial College Sports Ground, near Heathrow in Surrey (A. Barclay pers.

comm.). Thus even though pits are ubiquitous throughout the Thames Valley during the entire fourth millennium, diversity in content, morphology, and purpose is evident. Equally, midden material was sometimes, but not always, buried in the ground.

### *2.7.3 The purpose of pits*

Much new light has been shed on the Neolithic through pits and the material therein, thanks to the recently increased interest and accelerated rate of discovery. But what were the intentions behind this tradition of pit digging and deposition that lasted for more than 2000 years? The dismissal of the idea of storage pits in the Neolithic was not entirely helpful to our attempts to understand them. However, it is clear that this phenomenon is the product of a 'loosely bounded […] series of rules, which passed down through the generations with only minor modifications in practice' (Anderson-Whymark 2012: 188). Anderson-Whymark (ibid.) also points out that 'the circumstances under which a deposit accumulated may be quite unrelated to actions occurring at the point of deposition, although the materials are symbolically significant to the act'. This begs the question of whether the primary purpose of pits was to hold the deposited material or whether they were somehow used – independently from the midden accumulations – prior to deposition. The accumulations of material culture debris have been discussed in more detail than the pits themselves, although a few interpretations have been put forward in which the ultimate content is of secondary importance. For example, Case (1982 in ibid. 189) suggested that pits are the product of soil, stone, and chalk extraction. In this scenario, the final deposition of debris and soil into the pit is of minor significance. Another, more plausible, interpretation is that some of the pits were used for heat processing of food and craft material. Loveday (2012) argues that evidence from two sites in the Trent Valley in Derbyshire is indicative of pit roasting or cooking. For example, the pit beneath the Aston I round barrow displayed baked earth at its base and fire-induced colour changes in the soil (ibid. 102). At the nearby site of Willington, a pit containing 'large lumps of fired clay' was found (ibid. 105). The lumps were interpreted as remains of a collapsed superstructure which would have formed part of a pit-oven. I return to the idea of cooking pits in the British Neolithic in Chapter 7. Suffice to say here that this angle prompts us to think about whether or not pits were dug just before deposition. A lack of weathering and erosion of the sides of pits is often reported to indicate that the pit was dug primarily to hold occupational debris. However, if pits were dug in order to seal material debris in the ground, to hold some subterranean traces of the people who would return, why not bury all of it? Why leave some middens, or some portions of a midden, behind?

The purpose of pits no doubt varied regionally and over time. Likewise, the same community may have dug pits for a few different reasons. Crucially, however, the use of an empty pit for things like cooking and the sealing of socially significant material on leaving the site are not mutually exclusive practices. In my view, the pit itself and the content both mattered – separately during occupation, but jointly as the site was temporarily left. With time, small accumulations of intimately familiar material scattered the landscape, and this knowledge may have contributed to the emergence of deliberately placed deposits in pits and other cut features. I agree with Case (1982) in that the ultimate deposition of material is a secondary act. That is not to say, however, that the material itself is insignificant.

## 2.8 Four pit sites in the Upper Thames Valley

Thus pit sites have the potential to add new details to our understanding of life and settlement in the Neolithic. However, the material culture found in Neolithic pit features have to date been granted little scientific attention. For this reason, the pottery studied in this project was recovered from pits. Each of the four targeted pit sites are located in the Upper Thames region and were excavated during developer-funded investigations in the last two decades. These four sites were selected because they represent a range of different ceramic styles in the period c.3750-3000 BC. The ceramics and the techniques of lipid residue analysis are described in the next chapters. Here, the sites are introduced.

### *2.8.1 South Stoke, Oxfordshire*

The South Stoke Early Neolithic pit group was discovered in 2000 during investigations by Oxford Archaeology along the route of a pipeline between south Oxfordshire and west Berkshire (Timby et al. 2005). The site comprising nine pit features was encountered in a field north-east of the village of South Stoke, on the Thames around two kilometres upstream from the Goring Gap (ibid. 228). This is an archaeologically rich area; Palaeolithic and Mesolithic occupation is attested in the nearby Berkshire Downs, and at least three early Bronze Age barrow cemeteries survive in the vicinity as cropmarks (ibid. 207-8). Remains of Late Bronze Age enclosures and Early Iron Age hillforts are known in the uplands. The solid geology is Cretaceous Lower and Middle Chalk overlain by gravel in the South Stoke area. The river is flanked by alluvium on both sides.



**Figure 2.6** Neolithic pits at South Stoke. From Timby et al. 2005

*The pit group*

The Early Neolithic pit group was encountered in the northernmost section of the corridor of investigation, and comprised one cluster of seven pits and two smaller, isolated pits. Each of the seven clustering pits (5015, 5019, 5025, 5027, 5029, 5031, and 5035) yielded Early Neolithic pottery. No pottery was recovered from the two isolated pits (5021 and 5023), and they were assigned to the Early Neolithic on basis of their worked flints. The fills of all pits were largely similar, and all except one (5027) contained only one fill. No deliberately placed deposits were found, instead finds, ecofacts and charcoal were evenly distributed. Most pits were shallow and sub-circular in plan, although some variation in pit size and shape was recorded. The two isolated pits (5021 and 5023) were found 12m from the cluster of larger pits, and 6m from each other. The cluster of seven pits sits in a 4x7m area. The excavators suggest that six of the pits were dug as three pairs (Timby et al. 2005: 231). Charred hazelnut shells from four features yielded a radiocarbon date-range of 3650-3350 cal. BC.

*Flint*

The South Stoke pits contained an informative flint assemblage, nearly half of which was recovered from the two fills of pit 5027. The flint tool repertoire was restricted, comprising mainly edge retouched and serrated flakes (Cramp & Lamdin-Whymark 2005). Only three scrapers were found. This composition of the flint assemblage, along with the identification of silica gloss residues on twelve implements, suggests that plant processing was undertaken at the site (ibid.). Such tasks may be related to textile production involving reeds, rushes, and nettles, as well as food preparation. Use-wear analysis revealed that scraping, followed by cutting, carving, and boring, were all undertaken. The high proportion of knapping debris indicates that tools were manufactured at the site. Around one quarter of the flint was broken and c. 15% was burnt. The debitage component displays the highest frequency of breakage and burning. Recovery through sieving of burnt unworked flint fragments may be remnants of pottery manufacture, or at least ceramic paste preparation. Several different sources of flint are represented, such as nearby surface deposits in the chalk and nodules from the river gravels. Two flint hammerstones and three non-local flint pebbles were also found in the pits.

The flint assemblage also yielded clues about pit digging and deposition: five flints from pits 5025 and 5029 could be refitted, and may have been produced and placed into the pits around the same time. Fills and artefacts may represent 'the collected residue from everyday living' stored in temporary middens prior to burial (Barclay 2005a: 305). The relatively fresh condition of flints (Cramp & Lamdin-Whymark 2005: 266) suggests that such material culture debris did not accumulate on the surface for long periods of time before its deposition into pits.

*Plant and animal remains*

The Neolithic pit group was intensively sampled for environmental information and plant food remains. Wild and domestic plant taxa were recovered from all seven pits of the cluster (Huckerby & Druce 2005: 293). The assemblages are fairly small, in part due to poor preservational conditions (ibid. 296). Three samples from pit 5027 yielded the most substantial collection of twenty-nine whole grains and seventy cereal fragments. Wheat could be identified, but due to the lack of chaff it could not be further determined as emmer, spelt, or another variety. One single oat grain was found, but it need not have derived from a domestic variety. Charred hazelnut fragments were present in much larger quantities in all pits, and two indeterminate weed seeds were recovered from pit 5027.

Animal bone in poor condition was recovered from five pits, mainly from 5027 (Evans 2005: 292). Only domestic species were identified; the most numerous is cattle, followed by pig and sheep/goat. Nine cattle teeth were present, along with a mandibular ramus and a femur that had been chopped through the shaft, probably in order to reach the marrow. Pig was represented by five bones, one of which was an unfused distal tibia indicating death before age two. Three sheep/goat bones and eighty-nine unidentified fragments were also recovered.

*Charcoal and land snails*

Fifteen samples of charcoal likely to have derived from hearth fuel were recovered from six of the Neolithic pits (Gale 2005: 299). The six sampled pits yielded largely similar charcoal contents, representing mainly shrubby trees such as alder and hazel. Species of the Pomoideae subfamily, like hawthorn, blackthorn, apple, and pear were also identified. Charcoal of larger canopy-forming trees, notably oak and ash, was present in smaller quantities. Such a distribution probably reflects a preference for more easily obtained firewood from shrubby species, rather than the actual composition of surrounding wooded environment. The molluscan assemblage comprised a combination of shade-loving and open country species (Stafford 2005: 304). Even though the pit features may have been backfilled with soil containing non-contemporaneous molluscan fauna, it seems likely that the environment were made up of open, grassy areas, scrubland, and denser woods. For example, hazel, represented both as nutshells and firewood, requires well-lit or open conditions, while land snail species associated with mature, deciduous woodland were also present. The inclusion in the pits of what may have been former forest soils may also indicate that the area had been cleared recently, perhaps in association with the temporary occupation episodes during which the pits were dug and backfilled. Presence of *Ena montana* snails that live on the ground amidst timber debris illustrates the persistent but small-scale impact that human groups would have had on the immediate landscape.

### *2.8.2 St Helen’s Avenue, Benson, Oxfordshire*

The multi-period site at St Helen’s Avenue in Benson, Oxfordshire, was excavated by Thames Valley Archaeological Service in 1999 (Pine & Ford 2004). This stretch of the Upper Thames Valley would have seen a great deal of activity in the Neolithic, as indicated by nearby monumental sites and numerous stray finds of pottery, polished axeheads, and arrowheads. The monumental complex of Dorchester-on-Thames is found c. 4 kilometres to the north-west. A further 5 kilometres downstream is the North Stoke bank barrow complex. The site in Benson is located on the first gravel terrace, and yielded evidence of intermittent Neolithic, Bronze-Iron Age, Roman, and Saxon occupation.



**Figure 2.7** Neolithic and other prehistoric features at St Helen’s Avenue, Benson. From Pine and Ford 2004

A series of pits were assigned to the Neolithic and they were divided into three phases of occupation on basis of the styles of associated pottery. Gullies, postholes, and four possible post-built structures may belong in the Neolithic, but this outline focuses on the pits since the other features could not be confidently dated. The earliest phase of occupation (1a) is represented by one cluster of three pits (622, 625, and 626) all of which contained pottery and struck flint. One isolated pit (602) c. 20 metres north of the cluster was also assigned to phase 1a. The second Neolithic phase (1b) comprised the majority of features. The excavators' criterion of five or more sherds of diagnostic pottery brings nineteen pits into this phase. A further seven pits contained less than five similar sherds, and three pits yielded probable Neolithic struck flint but no pottery. Radiocarbon dates were obtained from hazelnut fragments from two pits (103 and 611) in phase 1b. These produced very similar results within the range of 3637 and 3368 cal. BC. Phase 1c comprised two pits, one of which (600) contained eight Peterborough Ware sherds and the other (220) a single Grooved Ware sherd. A majority of pits contained only one fill, and no deliberately placed deposits were identified.

*Artefacts and ecofacts*

A small assemblage (581 pieces) of struck flint was recovered from the Neolithic pits. The Upper Thames gravels are not rich in flint, but this site lies near the chalk outcrop of the Chilterns and the flint found is likely to have been sourced in the vicinity (Ford 2004, 159). Knapping debris makes up nearly 40% of the assemblage and the retouched component, including mainly serrated flakes and blades, comprises less than 15% of stratified Neolithic flints.

The majority of faunal remains from the site belonged in the Saxon phase of occupation (Hamilton-Dyer 2004). Only twenty-four fragments were recovered from the Neolithic features. Identified elements include a calcined pig carpal and a femur. Dog gnaw-marks can be seen on the latter. Cattle and sheep/goat were also represented. Several of the fragments had been subject to some burning. That such low quantities of animal remains were recovered from Neolithic contexts may not be a result of poor preservational conditions, since later period features yielded more substantial faunal assemblages. However, the fauna of the Neolithic features comprises mainly teeth.

Hazelnuts dominate the Neolithic charred plant assemblage. Only a single grain of hulled barley could be identified, found in pit 611 (Robinson 2004). It should be noted that only very small quantities of grains were recovered from late Bronze Age-early Iron Age and Saxon features as well, despite their better-attested economic significance in these periods.

### *2.8.3 Horcott Pit, Gloucestershire*

The site at Horcott Pit lies on the second gravel terrace between the rivers Thames and Coln near Fairford, Gloucestershire. It was excavated in advance of gravel extraction in

2002 and 2003 (Lamdin-Whymark et al. 2009). The gravel terrace is underlain by Oxford Clay and it is unevenly covered by a fine layer of peri-glacial clay silt. Evidence of major occupation episodes belonging in the Neolithic to Roman periods was recovered, and one diagnostic Mesolithic flint implement indicated an earlier presence at the site. The wide range of pottery recovered at the site represents a regionally important typological sequence, including Early Neolithic to Middle Iron Age styles (Edwards 2009: 90). The majority of Neolithic features were dated by their pottery to the fourth millennium BC. Activity at the site appears to have subsided in the Late Neolithic. In addition to pits, tree-throw holes and soil-filled natural hollows were present across the excavated area. The dense concentration of Neolithic features is notable since earlier excavations by Thames Valley Archaeological Services (TVAS) of two large areas immediately north of the site revealed no Neolithic features. However, those two areas are situated on the lower first terrace, whereas the Neolithic site is located on the elevated edge of the second gravel terrace. This elevated location may have mattered to its Neolithic inhabitants (Lamdin-Whymark et al. 2009: 120). Six pits were assigned to the Early Neolithic: one single pit, one pair of pits, and one group of three (ibid. 48). The Middle Neolithic was represented by sixteen pits and one tree-throw hole. Peterborough Ware was recovered from eleven pits that were encountered in three pairs, one group of three, and two isolated pits.

*Ecofacts and artefacts*

A large but poorly preserved faunal assemblage was recovered from the Neolithic pits (Evans 2009). Loose teeth were the most recurring identifiable element. Cattle dominate both in the Early and Middle Neolithic phases, although pig is almost equally represented in the later period. Sheep/goat is present in much smaller numbers in both periods, although preservational conditions may have been unfavourable towards sheep/goat and other smaller mammals (ibid. 110). A significant portion of the unidentifiable medium-sized mammal bones may belong to sheep/goat. Wild species were represented by three bones of red and roe deer, all recovered from Middle Neolithic features.

Despite its poor preservational condition, the faunal assemblage yielded valuable information regarding the keeping of livestock and processing of animal foods. The burnt component of the site's faunal remains was nearly all recovered from the Neolithic features. Butchery marks were detected only on cattle and pig bones, mainly associated with chopped limb bones for marrow extraction. Better preserved surfaces may have revealed further processing marks. Dental evidence from the Early Neolithic component indicates that a majority of cattle was killed as adults, although very young and senile individuals were also present. The smaller, Middle Neolithic cattle bone assemblage contained only one element that allowed age estimation, also belonging to an adult individual. Breeding of cattle in the vicinity of the site was indicated by the presence of juveniles and one single foetal bone (ibid.). Unfused skeletal elements of pig and sheep/goat demonstrate that, in some cases, they too were killed before reaching maturity. A notable deposit of faunal remains was recovered from the paired Early Neolithic pits (5949 and 5990) that were found in the south-west part of the site (Lamdin-Whymark 2009: 48). One of the pits contained a collection of animal bone that had been dumped



**Figure 2.8** Neolithic features at Horcott Pit. From Lamdin-Whymark et al. 2009 together. Butchery waste of four cattle, a pig and a sheep/goat was represented, and this collection was sealed by a charcoal layer rich in wild and domestic plant taxa.

The charred plant assemblage was dominated by hazelnut shell (Challinor 2009: 112). Identifiable cereal and fruit fragments included emmer wheat, crab apple, and blackthorn or sloe, albeit in very small quantities. The distribution of plant remains across the site varied greatly, from 43 fragments in one of the Early Neolithic pits to 1,359 fragments in a Middle Neolithic pit. However, no significant shift in plant exploitation can be detected between the periods. The flint assemblage, on the other hand, may indicate a change in plant use from the Early to the Middle Neolithic as there is a lack of serrated flakes in the later assemblage (Lamdin-Whymark 2009: 98). Serrated flakes are widely associated with plant fibre processing for production of cordage and textiles (Hurcombe 2007b). The flint assemblage contained material of multiple sources, including river gravels and a chalk region. One distinctive raw material variety would have been traded or brought from the Middle Thames region. The majority of Neolithic flint on the site was recovered from one single pit dating to the Early Neolithic (5990). The more numerous Middle Neolithic pits contained a smaller flint assemblage that included scrapers, knives, piercers, and one chisel arrowhead. Knapping debitage was more prevalent in the Early Neolithic flint component, but in both periods the range of tools present points to a diverse range of activities being undertaken at the site. Taken together, the assemblages are consistent with the regional pattern of more substantial flint assemblages associated with Early Neolithic pottery and smaller, more restricted collections of flint associated with Peterborough Ware (Lamdin-Whymark 2009: 101). Other finds included a quartzite axe polisher and a fragment of a pottery burnisher.

*Environment and occupation*

The charcoal evidence pointed to some open land with mature woodland nearby. Shrubby species such as hazel and blackthorn were present and seems to have been preferred for hearth fuel. The land snails recovered also indicated some shrub-land in the vicinity of the site, although the Early Neolithic pits yielded higher proportions of open-country molluscan species (Stafford 2009: 117). On this basis, Early Neolithic inhabitation seems to have been situated in a dry open landscape with some woodland nearby. In contrast, the Middle Neolithic land snail evidence is more diverse and dominated by shade-loving species (ibid.). Wooded conditions are further evidenced by two rare species that are considered to be particularly good indicators of closed, mature woodland. In addition, the grassland species that were present are dominated by a specimen that is able to inhabit woodland as well. This means that it is often the first land snail to occupy newly cleared areas (ibid. 118). Two molluscan species that live on and under tree trunks were also present. This all suggests that the forest was nearer the site during the Middle Neolithic. The clearing itself was smaller and less well maintained.

Clues about the duration and nature of occupation may be gained from the condition of finds and ecofacts. For the most part, the pottery and bone assemblages were found in poor states of preservation. Each episode of occupation may have lasted long enough for broken vessels and food remains to display signs of surface accumulation, but not long enough for flint debris to become worn. The excavators suggest that the midden accumulations from which the pit contents derived were relatively modest (Lamdin-Whymark et al. 2009: 120). Three of the Middle Neolithic pits stood out in that they have multiple fills (Lamdin-Whymark et al. 2009: 48). They were all located at the centre of the excavated area and two of them were paired. The secondary fills in all three pits were characteristic of hearth debris with plenty of ash and charcoal. One of them contained large sherds of a Mortlake Vessel that had been pressed into the pit wall with the decorated surfaces facing outward (ibid. 52). Early Neolithic bowl pottery and Peterborough Ware was not found to co-occur on the site, although that does not necessarily indicate that there was a lengthy break between Early and Middle Neolithic phases of occupation. The pottery is treated as two distinct assemblages, but it is worth keeping in mind that we could also make that temporal distinction at the level of each pit group. On the other hand, the Peterborough Ware component is dominated by Mortlake bowls, which is not the earliest style to emerge in the Peterborough tradition. No radiocarbon dates were obtained at Horcott Pit and the Early Neolithic bowl assemblage was highly fragmented, making it difficult to place it in the Early Neolithic sequence. Moreover, the differences between Early and Middle Neolithic phases observed in flint and molluscan assemblages should be kept in mind.

### *2.8.4 Cotswold Community, Gloucestershire*

The Neolithic site at Cotswold Community was found during a programme of excavations that took place between 1999 and 2004 in advance of quarrying (Smith 2010: 1). The site is located on the first gravel terrace between the rivers Thames and Churn, near Cirencester in the south-eastern corner of Gloucestershire. Aerial photographs had indicated that this was an archaeologically rich area, and several stages of occupation were indeed discovered from the Neolithic to the Saxon period. Before the Cotswold Water Park was created to mask the quarry scars, many small streams flowed through this landscape towards the Thames in the south (ibid. 2). East of the site, the ground rises steeply towards an outcrop of the Oxford Clay. The layout of occupation at the site was influenced by these features. Beyond the site, the landscape is known to be archaeologically rich – a Late Neolithic/Bronze Age cemetery, Bronze Age and Iron Age settlements, and a Roman field system are known nearby (ibid. 3). The earliest known presence at the Cotswold Community site dates to the Mesolithic. A tree-throw hole within the excavated area yielded Late Mesolithic flint, and more flints were found scattered across the site. The presence of Late Mesolithic flint is notable as it is unusual in the wider area. Thereafter, the first concrete evidence for occupation belongs in the Middle Neolithic, and this phase is represented by 13 pits. Late Neolithic Grooved Ware pits were also found. The Bronze Age phase comprises ceremonial monuments and burial in the earlier part and a subsequent shift towards settlement which persisted into the Iron Age (Powell 2010a: 11).



**Figure 2.9** Middle Neolithic features at Cotswold Community. From Powell et al. 2010

The Middle Neolithic pits were found isolated, in pairs, in and one group of three. Notably, isolated pits are more prevalent in this phase than in the Late Neolithic/Early Bronze Age phase. On the whole, they were located in two larger clusters in the south-western part of the excavated area. The pits were dated by the presence of Peterborough Ware pottery, and they indicate that the site was visited six or seven times in this period. One radiocarbon date from a Peterborough Ware pit places this phase of occupation at the end of the fourth millennium BC, around 3022-2926 cal. BC (68.2% probability) (Smith et al. 2010: 269).

*Ecofacts*

Hazelnut was the only species identified in the charred plant assemblages from the Middle Neolithic pit deposits (Smith 2010: 169). Notably, the Bronze Age plant assemblages were also dominated by hazel nutshell. In both periods, the nutshell fragments were highly fragmented and their weight suggests that less than 20 hazelnuts are represented in each pit (ibid. 173). This number is low enough for the nuts to have entered the pit deposits as hazel used as firewood rather than deliberate collection and consumption of nuts (ibid.). The charcoal evidence also indicates that hazel was the primary firewood in most deposits (Challinor 2010: 196). Other scrub species such as blackthorn and hawthorn were also represented in the charcoal samples and oak was present in smaller quantities. Overall the information from charcoal points towards a fairly open landscape. However, the molluscan evidence comprised only shade-loving species, although this need not be taken at face value since only one sample could be analysed (Champness and Stafford 2010: 203). A small faunal assemblage was recovered from the Middle Neolithic pits (Strid 2010: 209). As elsewhere on the Thames gravels, the bone is poorly preserved. Adult cattle could be identified, but other bone fragments were indeterminate.

*Lithics*

The Middle Neolithic flint assemblage is dominated by flakes (Lamdin-Whymark 2010: 62). The composition of the assemblage suggests that knapping was, for the most part, undertaken elsewhere. Debitage and cores are underrepresented, and no refits could be identified between pits. Even the flakes that were prepared on-site were made from partly prepared nodules that had been brought in. One of four flint hammerstones from the site belongs in the Middle Neolithic phase of occupation. The wear pattern suggests that it was used as a processor rather than a knapping tool (ibid. 69). The nearest flint source is several kilometres away and – similarly to the Horcott Pit assemblage – there is evidence for use of at least three flint sources, including the chalk to the south and the river gravels (ibid.

53). However, this community does not seem to have used the same flint sources as groups living elsewhere in the region. For example, the type of flint used at Yarnton in the north-east is absent at Cotswold Community (ibid. 72). The Middle Neolithic to Early Bronze Age pits tended to contain an equal amount of flints per pit in each group or pair (ibid. 61). This indicates that the contents of each pit group or pair represent the range of activities that were undertaken during that particular episode of occupation. The tempo of debris accumulation is also shared among the pits in each group or pair of pits (ibid.). The range of raw material sources and retouching debitage present in each group of pits may more accurately personal toolkits, brought together through movement and exchange (ibid. 72). In addition to the ongoing accumulation of debris, some larger deposits were placed in pits. These deposits were not formally arranged in the pit, but would include intact flint tools. Some plant working is indicated by the presence of serrated flakes, although they only make up a small proportion of the assemblage (ibid. 71). Other activities evidenced by the flint tool repertoire include cutting, woodworking, scraping hinds, and hunting. Another noteworthy component of the site lithic assemblage is the burnt stones recovered from two Middle Neolithic pits. The presence of burnt stone here and in the later features is interpreted as indicative of cooking (Powell 2010b: 82).

## 2.9 Conclusion

In the Thames Valley and beyond, the character of Late Mesolithic inhabitation lingered on during the early fourth millennium BC. Settlement patterns did not shift radically with the appearance of features that we associate with the Neolithic. Many Neolithic sites have yielded faint traces of a presence also in the Mesolithic. The Thames Valley Neolithic emerges in the archaeological record somewhat later than in adjacent regions. The radiocarbon framework suggests that the Neolithic makes an appearance in the Upper Thames region slightly earlier than in the Middle Thames. This is supported by more extensive early tree clearance in the Upper Thames. A few houses that date to the first quarter of the fourth millennium BC are known in the Thames region, but they would not have been occupied for more than a couple of generations. As elsewhere in Britain, settlement patterns were fluid, not fixed. When the first monuments are built we begin to see changes also in the distribution of settlement. Around 3750 BC, the rate of change accelerates – causewayed enclosures are built and evidence for domestic occupation becomes more frequent. After 3500 BC, large monument complexes emerge around a few cursuses in the Upper Thames region. Environmental evidence indicates that in the Middle Neolithic the forest takes back much of the grassland that had been cleared in the earlier part of the period. Throughout the fourth millennium, sites made up exclusively or primarily of pits are the main strand of evidence for domestic occupation. People returned to these places, sometimes only once and sometimes several times over the course of many years. Pits are more numerous towards the later part of the fourth millennium. Single pits become more common – both on their own in the landscape and as part of multi-phase sites with several pit-digging episodes. The later sites may represent shorter visits by smaller groups of people. A single pit from the end of the fourth millennium may be the trace of a pause in the landscape by only one or a few individuals and perhaps their animals.

# 3. Ceramics of the fourth millennium BC

*'In 1935 I was handed a parcel of sherds by the foreman of Mr Partridge's gravel-pit […] I have little doubt that all the sherds came from a single occupation-pit'*

E.T. Leeds (1940: 2, 6)

## 3.1 Introduction

The comment by Edward Leeds, recalling his first encounter with pottery sherds from Cassington in Oxfordshire, illustrates that prehistoric pits revealed through gravel extraction is not a recent phenomenon. The sherds in the parcel turned out to be from an Early Neolithic bowl, which Leeds referred to as 'Neolithic A'. That label is no longer in use, as bowl typologies have been repeatedly modified since Mr Partridge's gravel pit was excavated in the 1930s. This chapter attends to the pottery of the fourth millennium BC. I discuss the many labels that have been assigned to Early Neolithic bowl pottery, along with the history of research on Middle Neolithic Peterborough Ware. I argue that a lack of appreciation of the intimate settings of pottery manufacture is to blame for the opacity of our typologies. However, I take the view that ceramic studies are not a conservative subfield of archaeology. Instead, ceramics are capable of driving research into a wide range of topics. Today, ceramic studies are taken forward in three main directions: towards refined chronologies, enhanced applications of scientific techniques, and new theoretical insights. These approaches to the ceramic record are not mutually exclusive. Each recent approach or application brings great potential to the study of British Neolithic pottery. Yet many of the new techniques are destructive – including the analyses utilised in this study – and the majority of Neolithic sites in Britain do not produce large quantities of ceramics. This circumstance reflects comparatively low numbers of pottery makers and consumers rather than poor preservational conditions. Low average sherd weights indicate that the processes by which ceramics entered the archaeological record could be complex, and we are often left with a small reconstructable component. Prehistoric pottery is a finite resource, especially that dating to the fourth millennium BC. Therefore, destructive analyses must be situated within detailed understanding of the pottery itself.

## 3.2 Histories of research

### *3.2.1 Early Neolithic bowls*

Today, ceramics of the first three quarters of the fourth millennium BC are widely referred to as Early Neolithic bowls, despite evidence of regional and chronological variation. The appeal of such a vague label is to do with the numerous typological rearrangements of pottery of this period. Early Neolithic bowl pottery was first identified in the 1920s as plain bowls distinct from Peterborough types (i.e. Kendrick 1925; Leeds 1928). In 1931, Stuart Piggott developed Leeds' distinction between 'Windmill Hill' and 'Peterborough' ware (Clark 1966: 174). The former was divided into classes A1 and A2, and the A1 type was described as undecorated 'leather-bag skeumorphs' (ibid.). Later on, Piggott (1954) elaborated on this scheme. The term 'Western Neolithic' was introduced to denote a range of regional pottery styles, all seemingly related to contemporary Continental traditions. The Western Neolithic group included the Windmill Hill style, which in turn could be subdivided into 'Whitehawk', 'Abingdon' and 'East Anglian' wares (Cleal 1992: 286). In her influential doctoral thesis, Isobel Smith (1956) introduced the label 'Mildenhall' ware for the East Anglian style. Later still, Smith (1974) suggested the terms 'Hembury' and 'Grimston' to indicate further regional developments in south-western and eastern England. The Grimston label was not new, as it had been put forward in the 1920s as an alternative to the Windmill Hill label to denote all pottery that pre-dated the decorated Peterborough Ware (Clark 1966: 174). Smith argued that it was a regionally specific style but, as we shall see, this label eventually came to represent the very first pottery made in the British Isles.

In 1977, Alasdair Whittle argued that Smith's Hembury ware should be renamed 'South-Western', while Windmill Hill ware should be referred to as 'Decorated' and the Grimston Bowl as 'Eastern'. Whittle's explicit aim was to establish stylistic parallels with pottery on the Continent and thereby address cross-Channel influence on the British Neolithic. Whittle also argued that the insular typologies should be made less dependent on assemblages from large monuments of the period. Prior to this, Piggott himself had expressed 'a fading confidence in the Windmill Hill culture' (Case 1962: 212). Case and Piggott, both participants in the Prehistoric Society 1962 conference on the British Neolithic, agreed that a 'search for settlement-sites [would] be more rewarding' than a continued focus on monuments (ibid. 215).

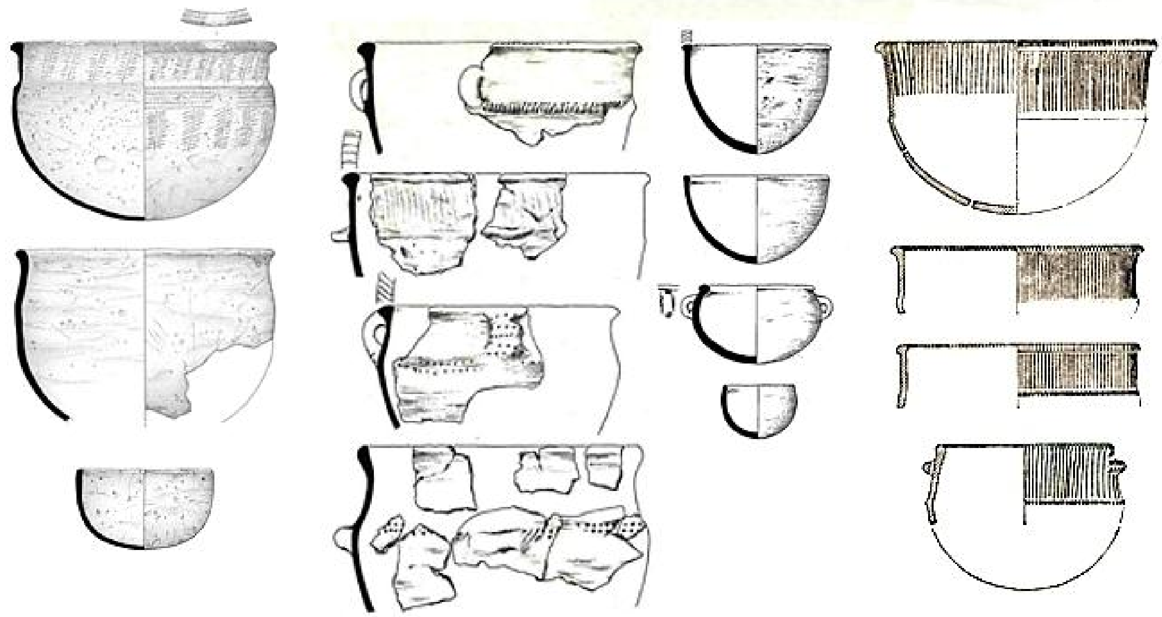

**Figure 3.1** Early Neolithic bowls from Kilverstone, Norfolk (left), Abingdon, Oxfordshire (middle), and Windmill Hill, Wiltshire (right). After Garrow 2006a, Avery 1982, and Zienkiewicz and Hamilton 1999

Indeed, a handful of excavated enclosure sites had been the foundation for early typologies. Abingdon (Oxfordshire), Windmill Hill (Wiltshire), Hembury (Devon), and Whitehawk (Sussex) are all Neolithic causewayed enclosures. These sites, along with a few long barrows, yielded assemblages that came to set the standards against which pottery found elsewhere was judged. This practice corresponded with contemporary interpretations of causewayed enclosures as camps or settlements (Oswald et al. 2001; Bradley 2007: 71). The idea of a Windmill Hill ceramic complex belonged to 'a time when it was thought that ditches of the Windmill Hill enclosure preserved the whole Neolithic sequence of the area' (Clark 1966: 176). It was thought that pottery was made and used at the large enclosure sites, and that pottery found elsewhere emanated from them. However, alternative interpretations were also put forward. At the 1962 conference, Richard Atkinson promoted the idea that the causewayed camps were 'fairgrounds' used during 'ritual feasts connected with periodical gatherings' (Case 1962: 215). This interpretation gained momentum during the 1990s. The notion of causewayed enclosures as permanently occupied settlements was dismissed in accounts that emphasised the ceremonial roles monuments and paid special attention to the structured depositions found within them (e.g. Whittle et al. 1999). As discussed in the previous chapter, this left archaeological models of Neolithic settlement patterns in a spot of bother.

Detailed studies of pottery assemblages contributed to the re-assessment of the role of causewayed enclosures. We have seen that an early petrological analysis of pottery from enclosure sites, pits, and 'open sites' indicated that material from the latter two was more likely to contain locally available clays and tempers (Sofranoff 1976). Smith (1965) demonstrated that a significant proportion of the pottery at Windmill Hill contained non-local inclusions. Early Neolithic sites on the Wessex chalk, such as the Maiden Castle and Robin Hood's Ball causewayed enclosures, yielded some shelly wares that are unlikely to have been made locally (Cleal 1992: 187). Accordingly, pottery was probably brought to the causewayed enclosures, rather than the other way round. Enclosure assemblages thus represent a series of different, more localised traditions of manufacture and use.

Situated in the centre of the Upper Thames region, the causewayed enclosure at Abingdon has been studied in ways which illustrate twentieth-century archaeological discourse on causewayed enclosures and Early Neolithic pottery typologies. The Abingdon enclosure was first excavated in 1926-7, and then again in 1963-4 in advance of development (Avery 1982: 10). In the main 1982 publication the site was interpreted as a settlement. However, new ways of thinking about the Neolithic were beginning to circulate. Humphrey Case and Alasdair Whittle (1982: 24) stressed that it may be unwise to focus solely on the idea of a large settlement. Moreover, the phenomenon later known as 'structured depositions' (e.g. Whittle et al. 1999) is in the Abingdon report referred to as a 'significant peculiarity' of 'carefully organised and purposeful burial of refuse in the ditch' (Case & Whittle 1982: 22). The pottery report includes unstratified material from the 1920s along with well-recorded sherds recovered during the excavations in the 1960s. The initial 'Abingdon ware' label was maintained in the 1982 report. This Abingdon style is characterised on basis of rim forms and decorations, and it should be relevant to contemporary pottery within a 50 mile area around the site (Avery 1982: 32). The 'problem' with this assemblage is that it also contains Windmill Hill-style material (Barclay 2002: 86). Conversely, the assemblage from Windmill Hill contains sherds of Abingdon and Mildenhall styles. In addition, the only extensively decorated vessels in the Thames Valley that pre-date Peterborough Ware were found at Abingdon and, therefore, highly decorated pots found in and beyond the region are frequently described as Abingdon ware. However, only one quarter of the vessels from Abingdon itself was decorated (Barclay 2002: 86). The bottom line is that 'there may never have been an Abingdon style' (ibid.).

Few attempts to rearrange or redefine the typologies have been made during the last few decades, although a notable exception is Andrew Herne’s study from 1988. He developed the idea that the assemblage of fine, undecorated, and carinated vessels from the long barrow at Hanging Grimston in Yorkshire was associated with a first horizon of Neolithic material culture in Britain. He put forward the influential argument that Grimston-type bowls are sufficiently widespread for it to be referred to as Carinated Bowl. The previous label of ‘Grimston/Lyles Hill’ for this supposedly early pottery had been promoted by Smith in 1974 and included both S-profiled and carinated forms (Cleal 2004: 108). Herne (1988) brought together all available radiocarbon dates and suggested that Carinated Bowl does indeed represent the earliest pottery in the British Isles. A carination is a ‘sharp change in direction or ridge in the profile of a pot, often forming a shoulder’ (Gibson and Woods 1997: 118). However, Herne’s scheme has been criticised for giving prominence to one particular vessel form, when in fact most assemblages comprise several different forms (Barclay 2002: 86). Similarly, he may have focused his analysis on assemblages that contained a deliberately restricted set of vessels (Barclay and Case 2007: 263). In order to stick to the Carinated Bowl as a real phenomenon, Herne (1988) had to define the difference between carinated and S-profiled forms. However, the distinction is likely to be artificial, and the chronological primacy of the Carinated Bowl is based on the rejection of early dates from un-carinated assemblages rather than on a positive body of data (Cleal 2004: 165). In addition, radiocarbon dates of this period were few and far between in the late 1980s, and they were still un-calibrated. Nonetheless, Herne’s (1988) placement of Carinated Bowls in the very earliest Neolithic has proved persuasive. Three points must be borne in mind if we are to adhere to this interpretation: first, ‘true’ Carinated Bowls are open, undecorated, and made of a fine ceramic paste. In other words, a pronounced carination does not make a Carinated Bowl. Second, the presence of Carinated Bowls in an assemblage does not necessarily place it in the first few centuries of the fourth millennium. Third, it may be valid to differentiate between two distinct stages within the Carinated Bowl style, although it is not certain whether the difference is chronological or regional/contextual (Barclay 2007a: 332; Barclay and Case 2007: 280). The earlier stage is characterised by very fine bowls on which a sharp carination occurs fairly low on the vessel profile, giving them ‘long’ necks which end in simple or lightly pointed rims (ibid). The potentially later stage comprises both fine and coarse vessels with heavier rims, shorter necks, and less pronounced carinations (ibid).

Shortly after Herne's paper was published, Ian Longworth (1990: 77) lamented the typological confusion and argued that 'the present definition of styles begins to look less than convincing'. Similarly, Rosamund Cleal (1992: 287) pointed out that the term Windmill Hill ware *could* be used to denote 'Earlier Neolithic pottery in Southern Britain, [or] a regional style of decorated pottery divided into sub-styles, [or] an early stage in that tradition without sub-styles, [or] finally, as a minor variant identified at the type-site although not now confined to it.' Inevitably, 'Early Neolithic bowl' is today the most commonly used label for pottery dating to the first three quarters of the fourth millennium BC. There are indeed several shared characteristics for this type of pottery. First, as recognised by Leeds and Piggott, the southern British ceramics of this period are distinct from later Neolithic styles due to their thinner walls and limited decoration. In fact, the finer and sometimes delicately decorated bowls of the first three quarters of the fourth millennium are more reminiscent of some Iron Age styles, such as Glastonbury Ware. Bases are invariably rounded, a feature which may have helped prevent them from cracking in contact with cooking-fire. Vessels with lugs or handles are present in most assemblages, albeit in small numbers. Decorations, if any, often constitute incised lines and/or impressions made with bird bone, reeds, fingernails, or twisted cord. In addition to carinated forms, plain and decorated vessels are major components of Early Neolithic bowl repertoires. These currencies are described below with reference to ceramic evidence from the Thames Valley.

### *3.2.2 Peterborough Ware*

The label 'Peterborough' ware was introduced to denote the profusely decorated pottery found in Peterborough, Cambridgeshire, by G.W. Abbott in the early twentieth century (Leeds 1940: 1). It then featured in the first published study of Neolithic pottery from southern England, produced by Reginald Smith in 1910 (Clark 1966: 173). In the 1920s and 30s, scholars were debating whether the Windmill Hill and Peterborough styles were contemporary or chronologically distinct (ibid. 174). Edward Leeds, himself born in Peterborough, suggested that undecorated ceramics had been brought to Britain from the Iberian Peninsula, whereas Peterborough pottery originated in Scandinavia and the Baltic region (ibid.). Piggott initially argued that Peterborough Ware was a later development, but he reconsidered when Peterborough sherds were recovered at the Whitehawk causewayed enclosure in Sussex. He thereby agreed with Leeds that the two styles were contemporary and 'geographically complementary' (Piggott 1927 in ibid.). The unlikelihood of insular, contemporary development of such different styles inspired further search for Continental origins. Childe (1935) concurred with Leeds on the Scandinavian/Baltic origin of Peterborough Ware, although a few years later he dismissed the idea that the Peterborough style was foreign. Instead, this was pottery made by acculturated 'residual food-gathering groups' (Childe 1940: 83 quoted in Clark 1966: 175). Thus the stage was set for Piggott's 'Secondary Neolithic' of 1954. In this model, characteristics of the British Late Neolithic (including Peterborough Ware) were the outcome of interactions between immigrants from Continental Europe and indigenous forager groups. Shortly after, Isobel Smith (1956) argued against contemporaneity of Windmill Hill and Peterborough wares.

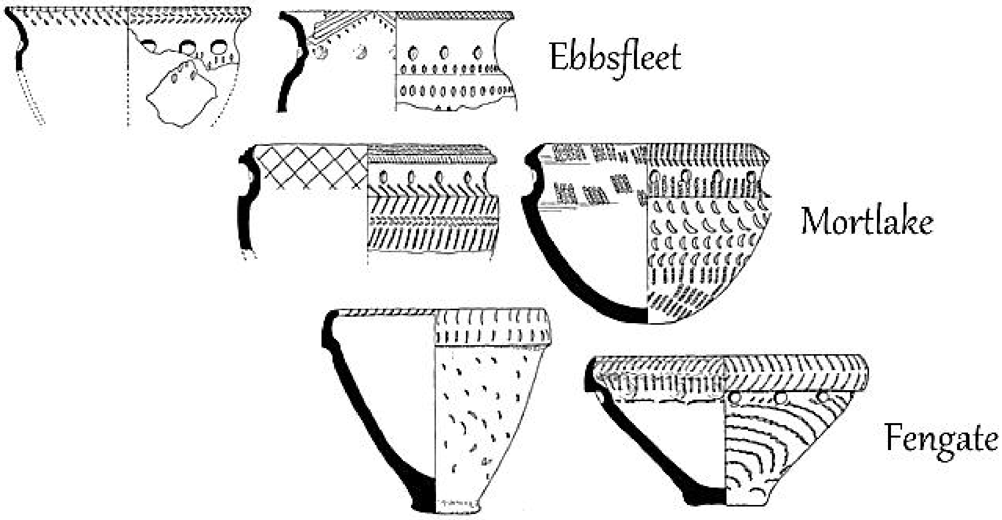


**Figure 3.2** Smith's three Peterborough Ware substyles. After Smith 1956

Based on 'all material known in the spring of 1956', Smith (ibid.: v) also offered a refined definition of the previously recognised Ebbsfleet and Mortlake substyles. The former had been defined according to the assemblage from Ebbsfleet, Kent (Burchell and Piggott 1939). Smith (1956: 69) re-examined the 'special' sherds from Peterborough itself, excavated by Abbott. Excavations had taken place in the Fengate area of Peterborough, and Smith added the 'hitherto imperfectly recognised' Fengate substyle to the Peterborough pottery complex (ibid. 69, 104). In her view, Peterborough Ware was a more 'dynamic' type of pottery than the preceding and later styles, and she emphasised that the three substyles represent 'an evolutionary series' in which Ebbsfleet is a continuation of

Windmill Hill type pottery (ibid.). Some geographical variation within south-east England was evident in the assemblages she examined. Ebbsfleet pottery was considered a southern development, whereas Fengate had only been found further north in the study region (ibid.73). Only in the Thames Valley did they two substyles overlap. In contrast, Mortlake style pottery had been recovered across south-east England.

All three substyles are made in the same fabrics as the earlier styles. Flint, shell, and sand are the dominant tempering agents (Smith 1956: 81; Cleal 1995: 187). The differences between the three substyles are to do with aspects such as form, rim styles, and decoration. Ebbsfleet pottery tends to be decorated only on the rim or the upper parts of the vessel wall and decorations are often 'open' and more shallow than on the other styles (Smith 1956: 88, 92; Clark 1966: 178). Decorative techniques include pitting, incising, and cord or fingernail impressions. In contrast to Mortlake and Fengate, Ebbsfleet bowls are reminiscent of Early Neolithic pottery in that the walls tend to be thin (Smith 1956: 81). Interior and exterior surfaces are often wiped or smoothed (ibid. 82). Vessels are bowl-shaped with clearly differentiated shoulders and rims tend not to be pronounced. Mortlake bowls are distinguished by extensive decorations and thicker walls. Rims are typically heavy and pronounced carinations give way to short concave necks (ibid. 95). Surface treatment such as smoothing is evident on a number of well-preserved Mortlake vessels, yet 'little attempt was made to press projecting grits back into the clay' (ibid. 94). Smith argued that the only flat bases observed in Mortlake assemblages appear to be accidental sagging prior to firing (ibid.). However, deliberately flat-based Mortlake vessels are known today. Pointy bases, on the other hand, are the hallmark of Fengate vessels. They may also be characterised by their elongated rims and straight profiles (ibid. 107). Smith suggested that Fengate vessels are either cylindrical or 'take the form of a truncated cone' (ibid. 110). She identified both accidentally and deliberately flattened bases (ibid. 111), a circumstance which inevitably raises the question of whether the flat base was an unintentional discovery.

Smith's body of work remains the most influential on Peterborough style ceramics. The tripartite division of Peterborough Ware was updated by Smith in 1974 and is still in use today. To an extent, the longevity of this typology is due to a dearth of further study. Other Neolithic pottery styles, such as Grooved Ware, have received a great deal more attention in the last five decades (fig. 3.3). The main problem with Smith's influential doctoral thesis is that 'there is very little direct stratigraphical evidence to support our hypothesis' of a developmental series within the Peterborough Ware ceramic complex (Smith 1956: 140). Important questions about Peterborough Ware pottery remain unresolved.

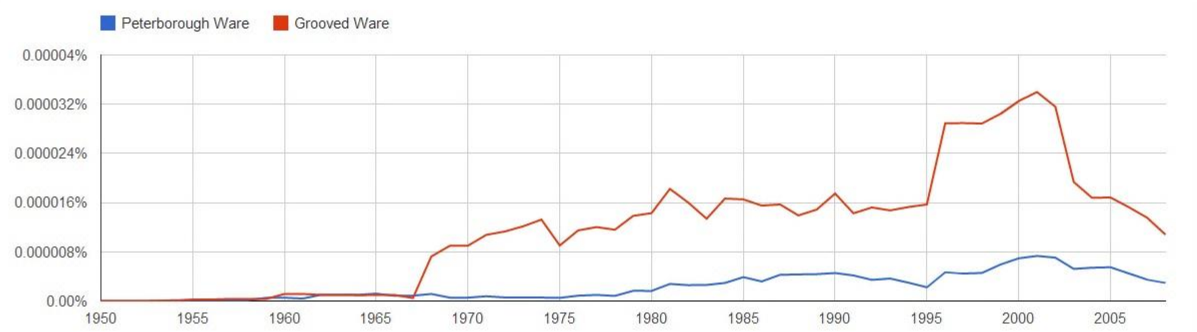


**Figure 3.3** Google Ngram illustrating the popularity in British literature of Middle and Late Neolithic pottery styles. The frequency of mention of Early Neolithic styles cannot be detected in this way due to the elaborate terminology (books only, smoothing: 3, British English).

### *3.2.3 The trouble with typology*

We have seen that Early Neolithic pottery was subject to many detailed studies during the twentieth century. In comparison, Peterborough Ware is an understudied group of British prehistoric ceramics. Perhaps as a consequence, Peterborough Ware typologies are more widely applied than those of the earlier bowl pottery. The research outlined above set the scene for more recent approaches to Neolithic pottery. Before considering such approaches, it is worth mentioning a few recent critical reviews of the typologies outlined. First, the near lack of primary source publication and subsequent evaluation in many of the typological rearrangements has been highlighted (Herne 1988: 12; Longworth 1990: 78). Equally, classifications based on a combination of unstratified material and a priori beliefs about stylistic succession are of questionable validity. By the 1990s, calibrated radiocarbon dates and a steadily increasing amount of excavated pottery had undermined the typological schemes for Early and Middle Neolithic ceramics (Longworth 1990: 77; Cleal 2004: 164; Gibson and Kinnes 1997). Cleal (2004: 180) brought together calibrated date ranges and presented a ‘ceramic-friendly chronology’ for the Neolithic of Wessex and south-western England. She had previously suggested that additional vessel features, such as volume, should be recorded for Neolithic pottery (Cleal 1992: 289). To an extent, this suggested shift in focus was a response to the overemphasis on carinations at the expense of other forms and attributes. Cleal (2004: 166) cautioned that the creation of Carinated

Bowls as a concept in fact masks significant diversity. Previously, Kinnes (1988: 4) had argued that generic use of the Grimston label 'effectively disguises both the actual distribution and potential regional variation, and the classification is widely-abused'.

A similar point has been made regarding the pottery 'lumped together' as Peterborough Ware, a label which in fact displays 'an immense variety in methods of manufacture, decoration, shape, and size' (Longworth 1990: 77). However, Peterborough Ware internal typologies have not received a great deal of attention since Smith's studies from 1956 and 1974. On the other hand, radiocarbon chronologies have had some impact. Previously, stylistic affinities between Fengate pottery and Collared Urns led both Smith (1956) and Longworth (1984) to place Peterborough Ware in the Late Neolithic and Early Bronze Age. This was supported by suggested Beaker style-influences on each of the Peterborough Ware substyles, put forward by Clarke (1970; Gibson and Kinnes 1997: 65). Today, the occurrence of Peterborough Ware can be placed between c.3500 and 2800 cal. BC (Gibson and Kinnes 1997: 67; Barclay 2002: 90; Bayliss et al. 2011: 778). Barclay's review of reliable radiocarbon dates suggests that Mortlake and Fengate styles developed around 3300 cal. BC, which is earlier than previously thought. Ebbsfleet style vessels were made and used alongside decorated bowls primarily between c.3500 and 3300 cal. BC, but this does not imply that the Ebbsfleet substyle subsided and gave way to the other substyles around 3300 cal. BC. In other words, Mortlake and Fengate-style vessels may in places be independent developments. Some regional diversity is evident. For example, Welsh Peterborough Ware often carries extensive birdbone-impressed decoration (Gibson 1995: 30). The idea of a linear sequence from Ebbsfleet through Mortlake to Fengate is not sustained by available radiocarbon dates or stratigraphy (Gibson and Kinnes 1997: 70). However, continued analysis indicates that only Mortlake and Fengate types are found on sites post-dating 3000 BC (Barclay 2007a: 332). A recent study of Peterborough Ware sherds from Willington, Derbyshire, suggests that Fengate style vessels went out of use before those of the Mortlake substyle (Beamish et al. 2009: 72). The radiocarbon study by Beamish et al. of the Willington pottery included only six sherds, but the dates were obtained from charred organic residues adhering to the ceramic rather than from associated material. Moreover, a Bayesian approach was applied to the dates, thus providing tighter chronologies for archaeologically interesting events as well as for the ceramic sherds (ibid. 63). In all, the new dates clearly set Peterborough Ware apart from Grooved Ware, and a Middle Neolithic phase is supported.

To summarise, the Neolithic pottery typologies put forward in the decades around the mid-twentieth century are no longer entirely valid. Nonetheless, many of the labels are still in use, partly because we lack convincing alternatives. My aim is not to dismiss the existing schemes or to propose redefinitions. However, I use the existing labels only to describe the vessel attributes that originally defined the label. They – Abingdon, Fengate, Carinated Bowl, and so on – do not necessarily have chronological, regional, or social implications. They do not in themselves tell us when and where the pottery was made and used. In my work on the ceramic assemblages from South Stoke, Benson, Horcott Pit, and Cotswold Community, I also adhere to Cleal's (1992: 290) classification of open, neutral, and closed vessel forms. As we shall see, content analysis indicates that these attributes reflect the ways in which vessels were used.

### *3.2.4 Contemporary approaches*

Many of the trends in contemporary ceramic studies are driven by advances in other corners of archaeology. We have seen that efforts to reconcile pottery typologies with refined radiocarbon chronologies are ongoing, in particular within Bayesian statistical frameworks (e.g. Beamish 2009). Rehydroxylation (RHX) dating of ceramic matter (e.g. Wilson et al. 2009) may also improve ceramic chronologies. Other advances in biochemistry have opened up new avenues of research. The UK Prehistoric Ceramics Research Group states that biomolecular analyses can 'take pottery beyond its usual social-chronological parameter and extend its influence on palaeodietary and palaeoeconomic fields' (PCRG 2010: 3). This development is discussed in detail in the next chapter. Biomolecules are not the only sources of dietary information contained in organic matter adhering to pottery – phytoliths (fossilized plant cells) and starch grains also shed light on vessel contents (Shillito 2013; Saul et al. 2013). This type of data may be considered alongside digital reconstruction techniques that improve estimations of vessel volumes (Brudenell et al. in prep.). Other recent approaches that originated in the natural sciences include applications of x-ray technology to archaeological ceramics. These techniques address pottery manufacture and distribution, and include X-radiography examination of the ceramic chaîne opératoire (Berg 2008) and X-ray fluorescence (XRF) elemental analysis of ceramic paste components (e.g. Jones 2009). Another promising approach based on x-ray techniques is the QEMSCAN® automated scanning electron microscope, which generates mineralogical information at much enhanced scales of analysis (e.g. Knappett et al. 2011).



**Figure 3.4** Monica Moses' (2013) 'craft preference profile' of six continuums: new ways of looking at and thinking about Neolithic pottery?

Alongside the scientific advances, a wide range of theory-driven questions continue to influence the study of ceramics. Thomas (1990: 82) summed up this direction by suggesting that 'to re-invigorate the study of Neolithic pottery we have to first ask ourselves precisely what we want it to tell us. I should contend that the answer to this question cannot come from the material itself, but must be formulated at a theoretical level'. Indeed, scientific analysis is not the only way in which we may take pottery outside its comfort zone. An example is provided by the contextual analysis of ceramics and other artefacts at Kilverstone, Norfolk, described in the previous chapter (Garrow 2006a). Here, contextual analysis of pottery and flint assemblages produced insights into the intermittent nature of occupation at the site. The Kilverstone study emphasised the end of a pot's life, from breakage to sherd accumulation and deposition. Alternative approaches assemble information that enables reconstruction of object biographies. In this way, the life cycle of a pottery vessel can be considered alongside its shifting meanings (Jones 2001: 84). That is, the meanings associated with an object are fluid and contextually dependant. Meanings alter along the life course of an object – in the case of pottery perhaps as it is fired, used by a new group of people, broken, or left behind. Accordingly, Jones' (ibid. 103ff) study of the Late Neolithic ceramics from Barnhouse in Orkney brought together petrological, organic residue and contextual data in order to address manufacture, use, and discard. Another angle is provided by detailed examination of the skill with which ceramics were made. Such perspectives may support discussions of cultural identity and kinship relations (Larsson 2008; Budden 2008). Perspectives from contemporary ceramic craft may also help us think outside the typological box (fig. 3.4).

Comparable lines of enquiry have been tentatively explored for the British Neolithic. For example, Smith (1956: 81) implied that Ebbsfleet vessels are better made than Mortlake or Fengate pots. This is seen in higher firing temperatures, thinner walls, and finer, grittier ceramic pastes. She noted that ‘a good deal of trouble was taken to beat out the walls and consolidate the joints’ (ibid.). Ironically, ‘mud-like’ fabrics at the type site in Peterborough itself demonstrate particularly inadequate firing and some sherds appear to have been wasters (ibid. 94, 106). Mortlake vessels are seen as a ‘better class’ of ceramics, whereas Fengate vessels are ‘sometimes incredibly ill-made and ill-fired’ (ibid. 106). Later on, potting skills deteriorated further; the difference in standard between Peterborough Ware and ‘curiously primitive’ Grooved Ware was commented on by Leeds (1940: 1). This verdict may be unduly harsh, given that Late Neolithic potters were capable of producing very large and intricately decorated vessels, as evidenced by the Grooved Ware assemblages from across Britain. However, the skill with which most Early Neolithic bowls – especially of the carinated kind – are often remarked upon (e.g. Gibson and Woods 1997: 64). Ceramic craft traditions of the British Early Neolithic have been explored from a local perspective (Sibbesson 2012) and in relation to the introduction of ceramics to Britain and Ireland (H. Pioffet in prep.). Importantly, Early Neolithic bowl traditions in Britain have also been brought into the Bayesian chronological framework produced on basis of radiocarbon dates from funerary monuments and causewayed enclosures (Whittle et al. 2007, 2011). The Thames Valley is at the centre of the region targeted by this recent radiocarbon programme.

## 3.3 Regional ceramic narrative

### *3.3.1 Early Neolithic bowls in the Thames Valley*

The ceramic narrative of the Upper and Middle Thames region begins with the rare assemblages made up exclusively of Carinated Bowls. As we saw in the previous chapter, the midden beneath the Ascott-under-Wychwood long barrow in Oxfordshire is one of the earliest deposits that yielded Neolithic material culture in the Upper Thames Valley. This midden contained a few Carinated Bowl sherds but no other type of pottery (Hey and Robinson 2011: 246). Later on, a few such sherds were redeposited in the chambers and the mound (Barclay 2007a: 342). Notably, no ceramics of Barclay's (2007a: 332, 2007b: 4) suggested earlier phase of Carinated Bowl are known from the Upper Thames Valley. Instead, the assemblages from pre-barrow contexts at Ascott-under-Wychwood and Hazleton North adhere to the characteristics of the potentially later horizon of Carinated Bowls. In contrast, at least one 'early' Carinated Bowl assemblage is known from the site at Cannon Hill near Maidenhead, Berkshire, in the Middle Thames region (Bradley et al. 1978). Later Carinated Bowl pottery has been recovered from the Eton Rowing Course middens (Hey and Robinson 2011: 246; Allen et al. 2004). The appearance of Carinated Bowl pottery across the Thames Valley and adjacent regions can be placed in the 38th century BC (Bayliss et al. 2011: 759). As illustrated at Ascott-under-Wychwood and Eton Rowing Course, but unlike the earliest ceramic assemblages elsewhere in Britain, the first pottery in the southern regions tends to derive from non- or pre-monumental contexts (ibid.).

| | **Carinated bowl** | **Plain bowl** | **Decorated bowl** |
|---|---|---|---|
| | *Appearance* | *Appearance* | *Appearance* |
| *95% probability* | 4185-3975 cal. BC˚ | 3970-3712 cal. BC | 3745-3690 cal. BC |
| *68% probability* | 4080-3990 cal. BC | 3855-3730 cal. BC | 3730-3700 cal. BC |
| | *End* | *End* | *End* |
| *95% probability* | 3715-3505 cal. BC | 3375-3095 cal. BC* | 3315-3245 cal. BC |
| *68% probability* | 3685-3595 cal. BC | 3355-3210 cal. BC | 3305-3270 cal. BC |

**Table 1.** Bayesian framework for the currencies of three main types of Early Neolithic bowls in southern Britain (from Bayliss et al. 2011: 759, 762, 763). *87% probability; ˚a date from Blackwall in Greater London is responsible for this early date, but no other Carinated Bowl-associated dates prior to 3800 cal. BC are known in southern Britain (ibid. 759).

Plain bowls also appeared during the 38th century BC in the Thames region, but they are more frequently found in association with dates from the 37th century (Barclay 2007b: 5; Bayliss et al. 2011: 756-768). This is again illustrated by Ascott-under-Wychwood, where the construction and use of the long barrow itself is associated with undecorated Early Neolithic bowls. A plain vessel with a heavy rim found towards the back of the outer passage of the barrow could been dated to 3640-3630 cal. BC (Whittle et al. 2007: 130). Stylistically, the pottery from Ascott-under-Wychwood mirrors the ceramics from other monuments in the Cotswolds, where assemblages tend to contain combinations of carinated and plain bowls along with minor components of decorated wares (Barclay and Case 2007: 279). Radiocarbon dates from other long barrows are also similar to those from Ascott-under-Wychwood. A bowl reminiscent of the decorated vessels from Abingdon was found in association with activity at the West Kennet long barrow, also dating to 3640-3630 cal. BC or before (Whittle et al. 2007: 131).

The term 'decorated bowl' is today used to jointly describe the regional styles of Mildenhall, Abingdon, Windmill Hill, and Whitehawk wares (following Whittle 1977). We have seen that these labels did not withstand the application of calibrated radiocarbon chronologies and vastly increased amounts of excavated pottery. Regional variation is evident, but they do 'grade into each other' (Bayliss et al. 2011: 762). What is more, decorated bowl-assemblages may comprise only a minor component of decorated vessels. Decorated and plain bowls are similar in terms of form and fabric, and to assign entire assemblages to one or the other may be misguided. Nonetheless, Carinated and plain bowl traditions pre-date the construction of causewayed enclosures, whereas decorated bowls are more strongly associated with the monuments (ibid. 773). Statigraphic sequences from a handful of sites in the Thames Valley and adjacent regions support the notion of a succession of appearance from Carinated to plain and decorated styles within the Early Neolithic bowl complex (ibid. 774).

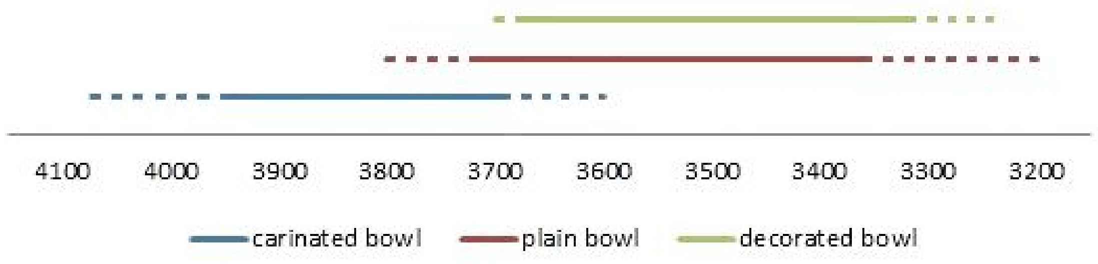


**Figure 3.5** Chronological framework of the three main types of Early Neolithic bowl pottery, based on the radiocarbon date ranges given in Table 1 (68% probability; horizontal axis: calibrated radiocarbon dates BC).

Several sites that underpin the recent chronological framework for the Early Neolithic bowl complex are located in the Thames Valley. Radiocarbon dates from South Stoke, St Helen's Avenue in Benson, Ascott-under-Wychwood, Hazleton North, Abingdon, and Gatehampton Farm were included from the Upper Thames region. In the Middle Thames, dates were provided from Runnymede Bridge and Cannon Hill, and from the causewayed enclosures at Eton Wick and Staines (ibid. 758, 760-762). Notably, pottery assemblages from the Eton Wick and Staines causewayed enclosures in the Middle Thames have not motivated further typological labels. This may be due to circumstances of investigation rather than characteristics of the pottery itself. The Staines enclosure is located opposite Runnymede Bridge on the bank of the River Thames. It was excavated under rescue conditions in the early 1960s (Robertson-Mackay 1987) and was subsequently obliterated through quarrying and, later on, highway construction. The three radiocarbon dates that could be tentatively re-analysed within a Bayesian framework placed activity at Staines around the 35$^{th}$ century cal. BC (Healy et al. 2011: 393). Further upstream, Eton Wick is located in an area of Berkshire rich in Neolithic remains, including those at Eton Rowing Course and Cippenham. It was excavated in the early 1990s (Ford 1993) and, by that time, attempts to classify Early Neolithic pottery had been largely abandoned. Radiocarbon evidence places the construction of the Eton Wick enclosure around 3500 cal. BC (Healy et al. 2011: 395). This relatively late date corresponds with the presence of Ebbsfleet-style pottery at Eton Wick. The Early Neolithic bowl pottery from the site is broadly comparable with that from Staines and Abingdon. The blending of regional styles within the Early Neolithic bowl complex is further illustrated by how the Staines assemblage is reminiscent of ceramics from the causewayed enclosure at Orsett, Essex, as well as from Abingdon. No clear distinction between Early Neolithic bowl pottery from the Upper and Middle Thames Valley can be made. Distribution patterns are also similar throughout the Thames region. Extensively decorated vessels are strongly associated with causewayed enclosures, whereas plain and minimally decorated vessels have been recovered from a range of different sites (Barclay 2002: 88). Carinated vessels are generally only one of several different forms, including closed, globular, open, and straight-sided vessels, sometimes with lugs or handles. By the mid-fourth millennium, Carinated Bowls were no longer made but plain and decorated vessels were used across the region.

### *3.3.2 Peterborough Ware in the Thames Valley*

In the spring of 1956, the Thames Valley was the only southern region in which the Ebbsfleet and Fengate substyles of Peterborough Ware overlapped (Smith 1956: 73). This observation no longer holds, since both styles have since been recovered in other parts of southern England and in Wales (Gibson 1995). Nonetheless, sites located in the Thames Valley are among the earliest to have yielded Ebbsfleet Ware. In the Upper Thames, they include St Helen’s Avenue in Benson (Timby 2004) and the Abingdon enclosure (Avery

1982). We have seen that the pottery from the causewayed enclosures at Eton Wick and Staines in the Middle Thames also comprised an Ebbsfleet component (Ford 1993; Barclay 2007b: 5). At each site, Ebbsfleet pottery is found alongside plain and decorated bowls. Notably, size ranges do not differ for Early Neolithic and Peterborough Ware bowls (Barclay 2002: 90). Smith (1956: 95) noted in passing that the bowl is not the only form of the Peterborough Ware complex. She mentions a couple of examples of 'shallow dishes or plates' (ibid. 107). The presence of dishes, jars, and cups are today recognised as fairly frequent in Peterborough Ware assemblages, albeit in small numbers and primarily within the Mortlake substyle (Barclay 2002: 90). An example from the Thames region include the dish from one of the pits at Horcott Pit (Edwards 2009).

Today, Peterborough Ware has been found in a variety of contexts within the region, including middens, pits, burial chambers, and ditches of monuments such as cursus monuments and causewayed enclosures (Barclay 2002: 90). In addition, at least 21 vessels have been recovered from the River Thames itself and others have been found in silted up palaeochannels. In fact, Peterborough Ware appears to have been more frequently deposited in water than other kinds of Neolithic pottery, primarily in the Middle Thames region (ibid.). Some of them may have entered the river from eroding bankside sites, although the majority are likely to have been placed in the water as votive deposits (ibid.). Barclay suggests that the large size of a significant proportion of these vessels may be a clue to their deposition in the river. If used for cooking and/or consumption of food, the content of such large bowls would have fed a larger group of people, perhaps at times when the wider community came together. Bowls of this size are generally not found in pit deposits in the Thames Valley, whereas in adjacent region large bowls are associated with burial monuments (ibid.). Nonetheless, more 'regularly' sized Peterborough Ware vessels are found in pits across the Thames region. Indeed, Peterborough Ware sherds were among the main items of material culture that were deliberately placed in cut features such as pits. The phenomenon of deliberately placed deposits seems to have gathered pace during the late fourth millennium BC, and it is a recurring feature of the Late Neolithic. Deliberately placed Early Neolithic vessels and other material culture items are rare, but not unknown (Thomas 1999: 65). Peterborough Ware pits with deliberately placed contents have been found at Yarnton in the Upper Thames and at Lake End Road West near Dorney in the Middle Thames region (Garwood et al. 2011: 332). At Horcott Pit, a Peterborough Ware sherd had been pressed into the wall of a pit with the decorated surface facing outward (Lamdin-Whymark et al. 2009: 120).

Towards the end of the fourth millennium, Mortlake and Fengate style pottery was made and used across the region. For example, deposits at the monument complex at Barrow Hills near Radley in Oxfordshire yielded four sherds of Fengate style pottery, along with the more substantial Late Neolithic and Bronze Age assemblages (Cleal 1999). Notably, these sherds came from poorly fired vessels, similarly to some of the Fengate pottery discussed by Smith (above). Further north in Oxfordshire, excavation under the Banbury Flood Alleviation Scheme recently uncovered a group of pits containing Peterborough Ware (R. Brown pers. comm.). Single Peterborough Ware pits are also known. At Wallingford in Oxfordshire, a circular pit containing up to nine Peterborough Ware pots was found (Richmond et al. 2005). The pottery assemblage is dominated by the Fengate substyle and most vessels were represented by single rim-sherds (Barclay 2005b: 81). The assemblage is somewhat unusual in that at least two vessels were grog-tempered and two others carry rare decorations (ibid. 82). Three pots had been used over a fire, evidenced by charred residues and sooting. The Wallingford area is the only location in the Upper Thames where Peterborough Ware has been recovered from the River Thames (Holgate 1988: 283). The Wallingford pit was dated to the very end of the fourth millennium BC (Ambers 2005: 81). A century or so later, towards the end of the Peterborough Ware currency, it overlaps with Grooved Ware but not with Beaker pottery in the Thames Valley (Barclay 1999).

### *3.3.3 Making and breaking pottery*

Certain aspects of the Neolithic ceramic record are relevant to all fourth millennium pottery in the Thames region. For example, the point of breakage may not have been the end of a vessel’s life during the Neolithic (Knight 2006; Barclay and Case 2007: 276). At Ascott-under-Wychwood there is little or no evidence of in-situ broken vessels (ibid. 278). Instead, pottery entered the archaeological record as secondary refuse. Much of it was recovered in fragments and sherds may have been trampled or partially collected before activity ceased. Some vessels did not survive the manufacturing process. For instance, there is evidence of a pot that probably exploded during firing at Ascott-under-Wychwood (Barclay and Case 2007: 266). Pieces of fired clay may also be wasters from firing events (ibid. 277), which is interesting as we do not generally associate monuments with pottery manufacture. The Ascott-under-Wychwood assemblage indicates that 'pottery production was perhaps not the result of a single controlled and organised event' (ibid. 277). This scenario can probably be brought to bear on most, if not all, Neolithic pottery in the Thames Valley, and it is critical for understanding the data presented in later chapters. That is, pottery was not made for trade or at centres that supplied wider areas. The vessels thus made constituted repertoires of bowls of different sizes, from cups to small, medium, and large bowls. A 'true' cup is of simple form with a straight or rounded profile, a simple rim, and a rim diameter of no more than 12cm (Smith 1956; Barclay and Case 2007: 267). In Wessex and parts of East Anglia, there is a tendency for smaller vessels such as cups to be made of sandy, non-flinty ceramic pastes (Cleal 1992: 187; Knight 2006: 29). This may be because cups did not need to withstand cooking heat. At Kilverstone, the smallest cup in the assemblage may not have been fired at all (Sibbesson 2012). The bowl component often included both fine and coarse wares which may have been intended for different purposes. Coarser pots tend to have walls that are at least 7mm thick. In contrast, the walls of some of the Carinated Bowls from Ascott-under-Wychwood were 4 to 5mm thick (Barclay and Case 2007: 268). Such thin ceramic walls appear to belong in the first three or four centuries of the fourth millennium. Later on, the uses to which ceramics were put seem to have required thicker and sturdier pots. This would imply that the roles of pottery changed during the period. At any given time, it is likely that a range of different vessels were made according to need. Spalling patches on vessel surfaces, indicating that they were not completely dry when fired, were present in the assemblages from Ascott-under-Wychwood and South Stoke. Vessels that were under-fired or not allowed to dry out before firing may have been made during the winter months. Aspects such as size, fabric, and wall thickness were adjusted to the vessel's intended function. However, that is not to say that each vessel type had one specific function or that the function stayed the same throughout a vessel's life.

## 3.4 Pit site assemblages sampled for lipid residue analysis

The pit deposits from South Stoke, Benson, Horcott Pit, and Cotswold Community yielded ceramic assemblages of both Early Neolithic bowls and Peterborough Ware. The next two chapters describe the techniques by which sherds from these assemblages were analysed. Here, the assemblages are described according to the themes discussed above: recovery of the 'death' assemblage, ceramic repertoires, manufacture, use, and breakage. Breakage and deposition are sometimes, but not always, closely associated. Either way, depositional circumstances bring us back to recovery during excavation.

### *3.4.1 The assemblage from South Stoke*

The seven clustered pits at South Stoke yielded 340 (1,420g) Early Neolithic pottery sherds, of which a minimum of ten vessels could be reconstructed (Edwards et al. 2005). Only two vessels could be reconstructed by more than 5%. One of them (P2) is a deep, near-straight sided bowl, which probably broke along the coil joint. The other (P6) is a closed bowl with an irregular rim and simple lug handles. Both vessels 2 and 6 have spalled surfaces and it is possible that spalling would have been present on other vessels, had they been better preserved. Most vessels were closed and/or S-profiled bowls, but at least one cup was present.

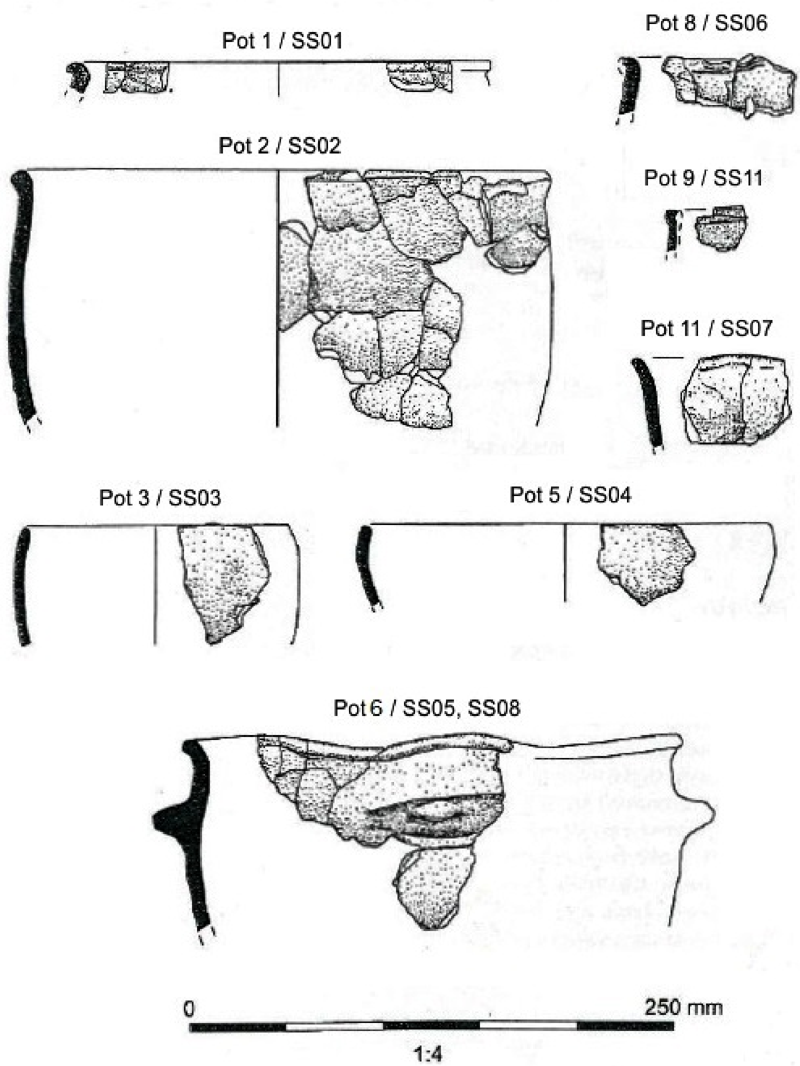


**Figure 3.6** Sampled vessels from South Stoke. After Edwards et al. 2005

Given the absence of shoulders and the predominance of closed forms, the South Stoke pottery resembles assemblages from the causewayed enclosures at Abingdon in Oxfordshire, Windmill Hill in Wiltshire, and Staines in Surrey (ibid. 328). Bowls were between 170 and 270mm in diameter at the mouth, and the cup 135mm. Only three vessels were decorated, two with diagonal incisions on or below the rim (P1 and P7) and one with incisions and point impressions on the body of the vessel. Rims include rolled, everted, simple, or externally thickened styles. A series of eight fabric groups was devised (ibid. 235). A majority of fabrics are flint-tempered with varying amounts of sand and occasional quartzite fragments. Two predominantly sand-tempered fabrics are also present. All fabrics are poorly sorted with uneven distribution of temper, and all raw materials are likely to have been sourced and processed locally.

Surfaces of around one quarter of vessels were smoothed, burnished, or wiped, although such treatment was irregularly applied (ibid. 236). Oxidised surfaces on some vessels and fire clouding on others imply short, open air firing, but some oxidation of vessel cores may have occurred during cooking. Some aspects of the assemblage point to the use of ceramic vessels in food-related activities. For instance, the majority of reconstructable vessels were of closed forms, suitable for cooking (ibid. 237). The ceramic fabrics are porous enough to withstand repeated heating over fire. Moreover, charred residues are present on a few sherds from pit 5026. The presence of at least one cup suggests that some components of the ceramic repertoire were used during display, serving, and consumption of food and drink.

Half of the reconstructable vessels were found in pit 5025. Two vessels were identified in pit 5027, and three other pits contained sherds of one reconstructable vessel each. Sherds within some features could be refitted, most notably in pit 5025, but no refits between pits were identified. The lack of worn and rolled edges suggests that sherds are unlikely to have accumulated on the ground for any significant period of time before being deposited in pits, although some blackened sherds may have been left in a fire (Edwards et al. 2005: 235).

### *3.4.2 The assemblage from St Helen's Avenue, Benson*

More than five kilogrammes of Neolithic pottery were recovered from the pits at St Helen's Avenue in Benson, of which a minimum of 30 vessels could be reconstructed (Timby 2004). Simple and carinated forms were present, and a majority of vessels were bowl-shaped. A couple of the reconstructable vessels were probably smaller cups or jars. Rims were simple, rolled, rounded, expanded, or triangular. Decoration is only found as incised lines on the rims of two vessels. At least two lugged vessels were present, as well as one with a strap handle (ibid. 146). The decoration and presence of lugs on a total of five vessels resemble the Abingdon style, yet at the latter site a much larger proportion of decorated vessels was found and nearly all pottery was made of shelly fabrics. The Benson assemblage was divided into two main fabric groups: two-thirds of sherds were tempered with calcined flint, and a smaller portion was a vesicular, shell-tempered ware. Probable Neolithic sandy, quartzite-tempered, and limestone-tempered sherds were also represented (ibid. 145). The only quartzite-tempered wares were found in the paired pits 101 and 103, located in the eastern corner of the excavated area. Pit 101 also yielded shell-tempered and flinty wares, while pit 103 contained sandy and flinty wares. The Neolithic component of the Benson pottery was especially well preserved (ibid. 144), which is probably a result of deposition soon after breakage.

The Neolithic pottery and associated features were divided into three typological phases. A fourth, Late Neolithic element was suggested as a single sherd of Grooved Ware was found. Nine vessels were assigned to the earliest phase (1a) given their carinated open forms and simple rims. Ten vessels belong to phase 1b on basis of their closed or straight-sided profiles and potential affinity with pottery from the Abingdon causewayed enclosure. The sherds found in pit 600 were tentatively interpreted as Mortlake or Ebbsfleet ware (ibid. 149). However, this division into three phases may be tenuous, since at least four features contained a range of different forms (ibid. 150). For instance, open and closed bowls were found together in pit 626, while pit 602 yielded carinated, straight-sided, and lugged vessels. The spatial arrangement of features across the excavated area may also be taken into account. For example, the cluster of three phase 1a pits aligns with three phase 1b-pits in a rectangular layout. The ceramic-based chronology of the site implies that occupation preceded and outlived the 300-year radiocarbon range that was obtained. At the beginning of this date range around 3650 BC, open carinated pottery forms are still found

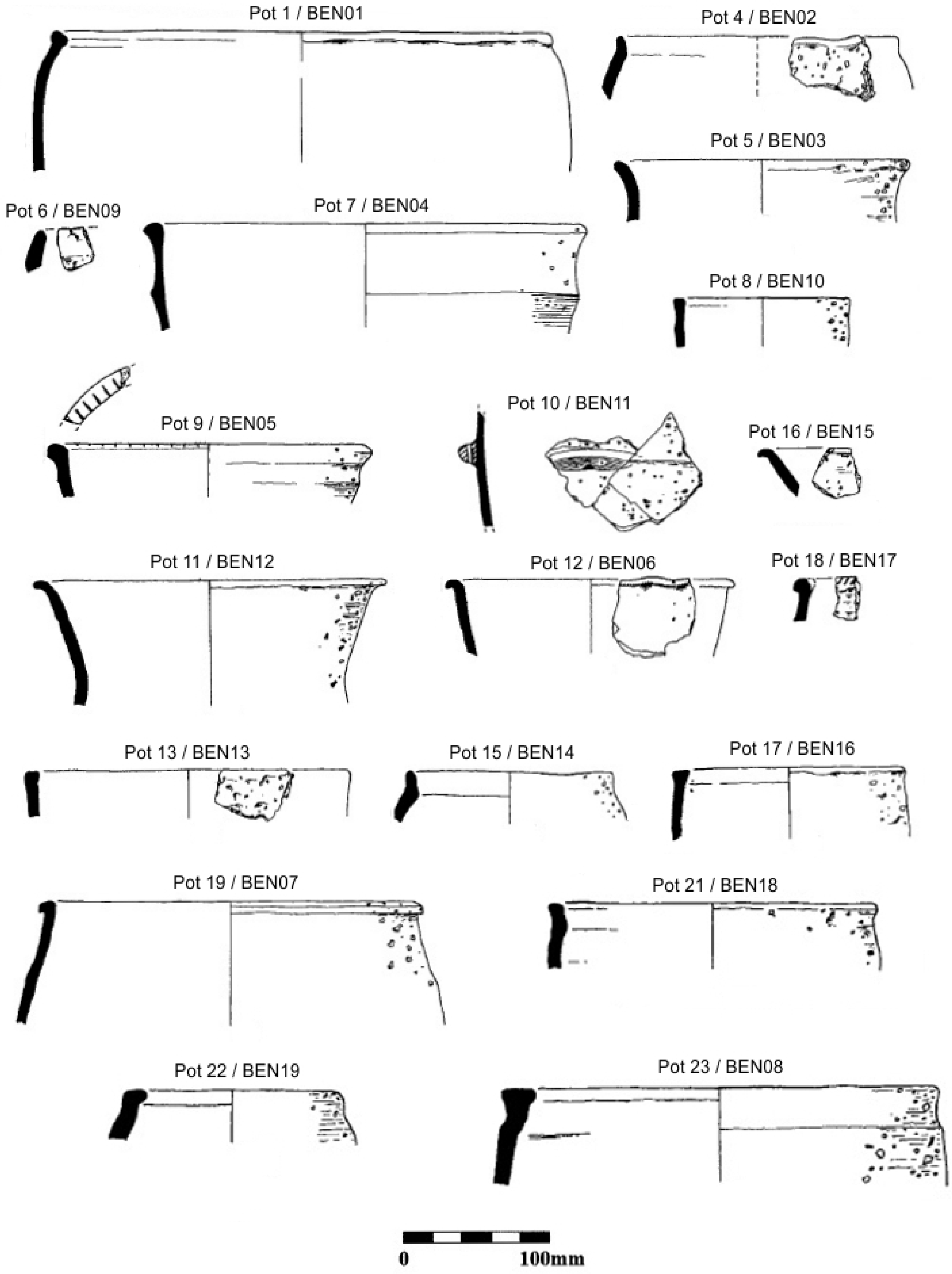


**Figure 3.7** Sampled vessels from Benson. After Timby 2004

across southern Britain, even if we apply the more restrictive label of Carinated Bowl (Bayliss et al. 2011: 759). The Abingdon enclosure is located c. 10 kilometres north-west of Benson. Further afield, the Whiteleaf barrow in the Chilterns and the causewayed enclosures of Windmill Hill in Wiltshire and Staines in Surrey produced assemblages with some affinity to that from Benson (Timby 2004: 149). The assemblages from Staines, Abingdon, and Whiteleaf also comprise some heavy expanded rims that seem to anticipate Ebbsfleet ware. The division of occupation into three discrete 'phases' probably masks a degree of continuity, even though the site may have been occupied intermittently.

### *3.4.3 The assemblage from Horcott Pit*

The pits at Horcott Pit near Fairford in Gloucestershire contained a prehistoric pottery assemblage with Early Neolithic to late Iron Age components (Edwards 2009). No radiocarbon dates for the site were obtained. Neolithic plain bowl, Peterborough Ware, and Grooved Ware traditions were represented. The large size of this assemblage makes the site at Horcott Pit unusual in the Upper Thames region. Six pits yielded 257 sherds of Early Neolithic bowls (ibid. 81). A minimum of seven plain bowl vessels and one minimally decorated bowl could be reconstructed. The reconstructable component included one carinated vessel and at least one cup. Two of the bowls were large, with rim diameters above 30cm (ibid. 84). Several of the vessels had been smoothed during manufacture, but most sherds display signs of poorly controlled firing.

Unfortunately, average sherd weight is low for the Early Neolithic component. The vessels appear to have been substantially used, and some further fragmentation may have occurred after breakage (ibid.). Abraded surfaces are observed on all diagnostic sherds. It is likely that these sherds were left on the ground for some time before ending up in a pit. The six pits that yielded this Early Neolithic assemblage also contained animal bone and struck and worked flint. One hammerstone and two amorphous fired clay fragments were also recovered (Lamdin-Whymark et al. 2009: 50). The latter may indicate that pottery was made at the site, at least at one occasion. The largest quantities of pottery sherds were recovered from two pits found within a cluster of at least three features. An isolated pit yielded a group of sherds that may derive from a single vessel. No deposits contained both Early and Middle Neolithic pottery. The Middle Neolithic component was more substantial and marginally better preserved (Edwards 2009: 81). Over two kilogrammes of Peterborough Ware pottery was recovered from eleven pits and a minimum of nineteen vessels could be reconstructed. The majority of vessels belong to the Mortlake substyle, but one Ebbsfleet and two Fengate bowls were also present. As mentioned, this repertoire also comprised one possible dish (P14). The only other Peterborough Ware assemblage in

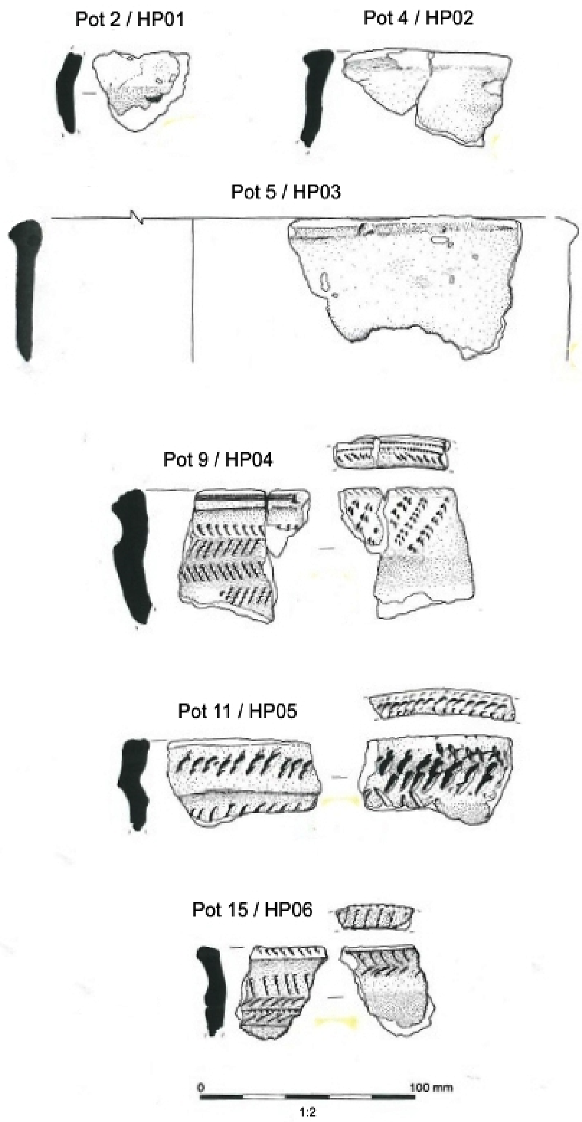


**Figure 3.8** Sampled vessels from Horcott Pit. After Edwards 2009

the Upper Thames region with a similarly wide range of forms present is that from Yarnton in Oxfordshire (ibid. 73). At least three small bowls are present, but no cups. Unlike the pottery from South Stoke and Benson, the Horcott Pit assemblage is primarily shell-tempered. Some variation within the shelly tempers is recorded, but this probably results from geological variability in superficial deposits and availability at the time of pottery manufacture rather than deliberate selection. Less frequent sand- and grog-tempered sherds are present, along with a fine untempered fabric. Little or no correlation was observed between form and fabric within the Middle Neolithic component. On the other hand, an association between shell-tempered bowls and twisted cord decoration may be relevant (ibid.). A few different decorative techniques, including birdbone and fingernail impressions, were used on the untempered vessels. The skill and attention with which these vessels were made probably varied, although overall this is a relatively well-made assemblage. One Mortlake bowl in particular (P9) stands out as unusually skillfully made, as it is neatly decorated and evenly fired to an orange colour. The ceramic paste was sparsely tempered with sand and fossilised shell. At least two vessels had smoothed surfaces as well as impressed decoration. Variation in the depositional circumstances of these sherds is also evident. Only three vessels could be reconstructed by more than 5%. There are several large sherds within the Peterborough Ware component that may have been deposited into pits relatively soon after breakage. At the same time, worn and abraded smaller sherds are also present. The point at which a vessel broke during an episode of occupation may be one determining factor for its condition once buried in a pit. Alternatively, durations of occupational episodes may have differed. If so, features with worn and abraded sherds may reflect longer visits to the site. However, sherds of varying conditions often occur in the same pits, indicating that the former scenario is more likely.

### *3.4.4 The assemblage from Cotswold Community*

The smallest and most fragmented pottery assemblage included in this study is that from Cotswold Community in Gloucestershire (Brown and Mullin 2010). The average sherd weight of the Peterborough Ware assemblage was only 3 grams, and over half of the prehistoric sherds were highly abraded (ibid. 1, 5). This fragmentary state is uncommon in the Upper Thames region. Worn fractures indicate complex depositional circumstances for each of the Middle Neolithic to Middle Iron Age assemblages. The Peterborough Ware component was recovered from thirteen pits and two postholes. A minimum of twelve vessels could be reconstructed from nearly 600g of pottery, although most are represented only by a single sherd. Sherds of one bowl (P2) may represent the collar of a Fengate vessel, while the other three are likely to represent the Mortlake tradition. The majority of prehistoric pottery recovered at the site was made of relatively fragile shelly fabrics. Notably, the flint-tempered vessels belong to the Middle Neolithic and Beaker phases of occupation. If the flinty wares represent pottery that had been brought or traded from elsewhere, this practice appears to have ended in the Early Bronze Age. Alternatively, clay outcrops to the south of the site in Wiltshire may have gone out of use. As at Horcott Pit, a small grog-tempered component is also present.

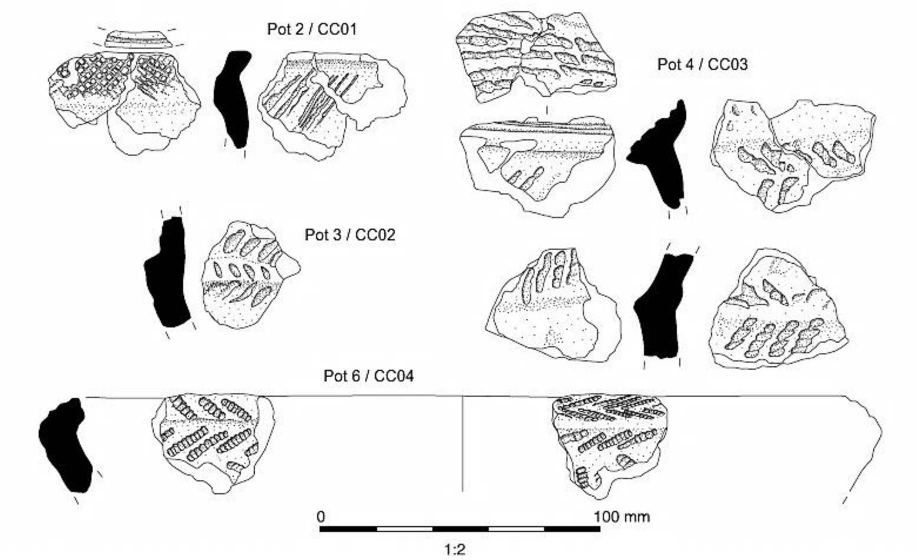


**Figure 3.9** Sampled pots from Cotswold Community. After Brown and Mullin 2010

One quarter of the Peterborough Ware sherds were recovered from one pit (8799), which formed part of a cluster of three pits arrange in a line (Powell 2010a: 14). An isolated pit (10206) contained another substantial collection of sherds, including remains of a fine Mortlake bowl. No deliberately placed sherds were identified. The Middle Neolithic pit features at Cotswold Community have been radiocarbon-dated to the very end of the fourth millennium BC. It represents the latest assemblage included in this study.

## 3.5 Conclusion

This chapter has placed the four targeted assemblages in their typological, theoretical, and local contexts. Histories of research illustrate that the character of occupation and material culture use during this period defy easy classification. In other words, the regional and chronological variation that can be observed in the ceramic assemblages is too subtle to sustain any practical typologies, especially for the Early Neolithic bowls. Nonetheless, traditional methods of ceramic analysis have fulfilled our most pressing questions and they provide a framework for the four pit site assemblages. Recent approaches rely to a greater extent on techniques developed elsewhere, both in archaeology and beyond. Integration of traditional ceramic study with more recent approaches underpin the discussions in each of the remaining chapters.

# 4. Lipid residue analysis of ceramics by GC/MS and GC/C/IRMS

*'What else is to be expected from something defined largely by the void at its centre and its ability to contain a near-infinite variety of things?'*

J. Lasky 2013

## 4.1 Introduction

In the late 1950s, two teams of scientists published the results of the first successful couplings of a gas chromatograph with a mass spectrometer (Sparkman et al. 2011: 5; Holmes & Morrell 1957; Gohlke 1959). Mass spectrometry and chromatography had been available since the turn of the century, but since contemporary mass spectrometers could only operate with gaseous analytes it was through the development of gas chromatography in 1950 that the two techniques could be combined (Sparkman et al. 2011: 4). Their successful combination also depended on the development of an interface capable of reconciling the high flow rates of early gas chromatographs with the low pressures required by the mass spectrometer (ibid.). The subsequent development of such an interface resulted in a powerful instrument that is used today across the natural sciences. This chapter attends to the techniques of biomolecular analysis of ceramic residues by gas chromatography/mass spectrometry (GC/MS) and gas chromatography/combustion/isotope ratio mass spectrometry (GC/C/IRMS). However, comprehensive reviews of the many techniques that target archaeological residues can be found elsewhere (e.g. Evershed 1993, 2008a; Regert et al. 2003; Barnard and Eerkens 2007). Here, I discuss how this line of enquiry became a routine application in archaeology, and I describe the procedures by which the data is obtained and interpreted. I emphasise that it is a multi-step process that involves several methodological and interpretive challenges. Finally, I discuss the ways in which this type of data can be reconciled with the inorganic record and with more traditional strands of archaeological knowledge.

## 4.2 The ‘organic residue revolution’

Archaeological study of ceramic residues was in its infancy in the 1970s (Renfrew 1977: 6; Bonfield 1997: 1). Techniques and instruments developed in other disciplines could not be applied without modification to residues from archaeological contexts. Early studies of the latter were held back by dissimilarities between geological samples and the extremely small and partly-degraded residues of past human activity (Brown and Brown 2011: 55). In a classic study by Condamin et al. (1976), degraded lipids were detected in a Roman amphora from Spain. The carefully worded introduction illustrates that the study was tentative: ‘…we took into account the porous structure of ceramics and thought that the oil constituents could have migrated through the amphora and be retained there even if in very small quantities. They ought therefore be traceable either in their original form, or in the form of degradation substances. We therefore tried to reveal and identify these compounds in amphora fragments, making sure each time that the larger part actually came from the contents of the amphora and not from animal or vegetable contamination from the surroundings’ (ibid. 195). The identified lipids were interpreted as traces of olive oil, but due to their poor state of preservation this inference relied on prior knowledge of the function of Dressel 20 amphorae. In this case, the actual detection of lipids was perhaps more significant than the information it generated. Since then, we have moved on from questions of whether traces of ancient meals can be detected to instead consider their constituents and wider implications.

The potential of this rapidly expanding line of enquiry was brought to the attention of the wider discipline in the 1990s due to a series of successful applications of the combined GC/MS. For example, Charters et al. (1995) were able to detect animal source foods, possibly associated with tallow production, in two Saxon pottery vessels from West Cotton in Northamptonshire. In addition, identification of beeswax traces led the authors to suggest that it had been used to seal the porous walls of the vessels (ibid. 123). Around the same time, issues related to contamination and molecular alteration were addressed in a series of influential experiments (e.g. Heron et al. 1991; Charters et al. 1993; Evershed et al. 1995). The combination of techniques, i.e. the separation of compounds by GC followed by their identification in a mass spectrometer is still the most widely used method in lipid residue studies (Brown and Brown 2011: 62). However, the 90s has also been described as the troublesome adolescence of residue studies (Bonfield 1997: 1). This implies that we are currently in a more mature stage, and that the many pitfalls that often accompany new lines of scientific enquiry are taken into full account. Alternatively, and more cautiously, the conceptual childhood of residue studies could be extended into the 21st century. As we shall see, certain interpretive and methodological difficulties remain to be understood and addressed (Eerkens 2007: 90).

Either way, a shift in archaeological attention from inorganic to organic materials is underway. In the traditional definition organic compounds are those that contain carbon while those that do not are inorganic. However, there is overlap even at such fine scales, and further subdivisions are devised as research continues (Pollard et al. 2007: 32). Inorganic materials form the backbone of the archaeological record, yet organic items are the 'missing majority' of past artefact and ecofacts repertoires (Hurcombe 2008: 85). The expanding field of biomolecular archaeology, of which organic residue study is part, is beginning to redress this imbalance. Experimental work that aims to improve analytical rigour is ongoing (e.g. Craig et al. 2004; Evershed et al. 2008; Gregg and Slater 2010). Jones' (2008: xiii) reminder that the endeavour 'remains something of a forensic adventure rather than a routine scientific procedure' is valid given how recent many of the applications are. Indeed, the 'organic residue revolution' is still unfolding, and its parameters are not yet fixed (Evershed 2008a: 895). In my view, one relatively overlooked line of enquiry arises from integration of 'traditional' archaeological ceramic study with lipid residue data from pottery.

## 4.3 The techniques

### *4.3.1 GC/MS*

Living organisms are made up of many different chemical substances and those that have survived the death of the parent organism to the extent that they may be archaeologically identified are labelled 'ancient' (Brown et al. 1993: 64). The chemical substances of the organism can be divided into different classes of biomolecules, such as lipids, proteins, alkaloids, and carbohydrates. Lipids are most commonly targeted in residue analysis due to their ubiquity in nature and their relative resistance to decay. Among the lipids, the most frequently analysed class are fatty acids (Barnard et al. 2007: 42). Fatty acids are a type of carboxylic acids in which the R group is a complex hydrocarbon chain (fig. 4.1). The

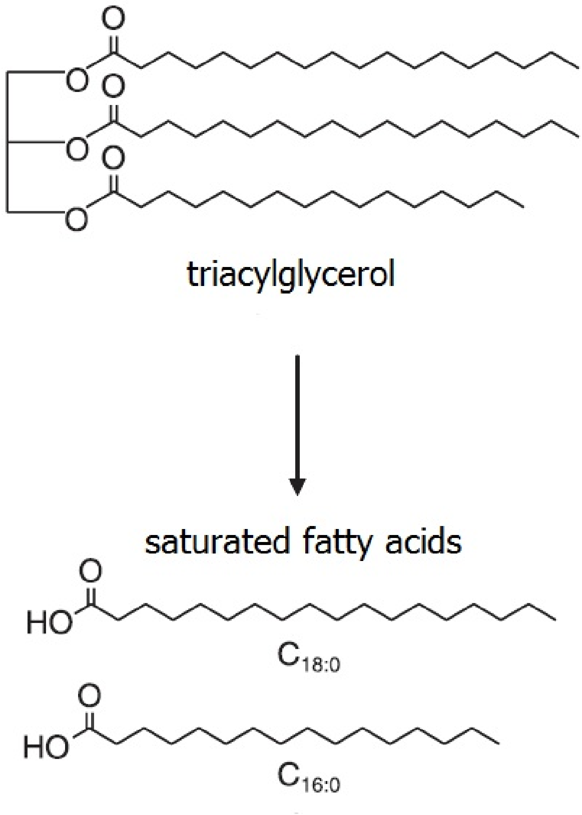


**Figure 4.1** Triacylglycerols break down into free fatty acids. After Evershed 2008

aliphatic chain comprises 4 to 36 carbons with attached hydrogen atoms (Brown and Brown 2011: 55). Lipids occur archaeologically in different kinds of residues but this project targets those that were absorbed into the ceramic vessel wall in prehistory. In the laboratory, the absorbed lipids must be separated from the ceramic matrix. The first step is therefore to either crush a pottery fragment with a pestle and mortar or grind off enough ceramic powder (c. 100µg per extraction) with a drill. Gloves are worn and the surface millimetre of the ceramic is discarded to reduce contamination. The powder is then treated with a solvent (generally a 2:1 mix of chloroform and methanol) that dissolves the lipids. Treating the ceramic as a powder rather than as a fragment or sherd maximizes contact between lipids and solvent (Barnard et al. 2007: 46). Ultrasound sonication of the mixture also contributes to the separation of lipid and ceramic matter. The mixture is then centrifuged or filtered, and the clear liquid is transferred to a vial. The lipids are now contained in this clear liquid, and the sediment-like wet ceramic powder can be discarded or stored for further extractions. The solvent in the vial is thereafter evaporated, often with nitrogen gas. Additional treatment that, for example, helps increase the concentration of free fatty acids can then be added to the process. The internal standard can be added at this stage or earlier, when the lipids are still mixed with the ceramic powder. The internal standard is a known amount of a known compound, which facilitates quantitative (but not qualitative) analysis and indicates that the extraction has been successful. Finally, the dry sample is derivatized in order to make the compounds more thermally stable and less polar. This involves adding a derivatizing agent that generates esterification (methylization) and silylation (ibid. 47). Heating the samples to 60-70˚C will enhance the reaction between lipids and solvent. The solvent is again evaporated and the lipid extract is suspended in a solvent such as n-hexane when it is injected into the GC.

In the GC-part of the instrument, the sample is vaporized and carried within a carrier gas (usually helium) through a long, thin glass column. The interior walls of the column are coated with a chemical (the stationary phase) that will compete with the carrier gas (the mobile phase) for the molecule in the sample. The time it takes for each molecule to navigate the stationary and mobile phases depends on chemical characteristics such as its weight. This retention time is recorded as the compounds elute from the column and it is an important clue in identification of the compounds present. If the GC is coupled to an MS, the end of the column is inserted into the ion source of the MS (Pollard et al. 2007: 174). Here, the molecules are hit with high energy electrons, which produce positive molecular ions as electrons are removed (ibid. 175). This makes the molecules fragment in reproducible patterns that enable comparison with known compounds. The molecular ions are scanned for their mass to charge ratio (*m/z*), with the result that a mass spectrum is produced for each molecule in the extract. The output of the entire extract is expressed as a chromatogram, in which the retention time of each molecule is plotted against its frequency (relative to all other molecules in the extract) (fig. 4.2). Modern GC detectors respond in proportion to the amount of each component in the sample, thus enabling quantification as well as identification (Pollard et al. 2007: 145). Quantification is achieved by comparing the areas of the unknown peaks with the peak area of the internal standard.

Each peak in the chromatogram represents a compound present in the lipid extract. The peaks are interpreted according to their retention time and the mass spectrum that is available for each peak. The mass spectra are compared to those of known substances and compounds in a digital library. Both general and specialist databases are available, although the latter are primarily constructed by and for those working with fossil fuel and synthetic compounds (Sparkman et al. 2011: 151). For archaeological purposes the identification of frequently occurring substances is best achieved through a combination of experience and familiarity with modern reference samples and the relevant literature (Pollard et al. 2007: 175).

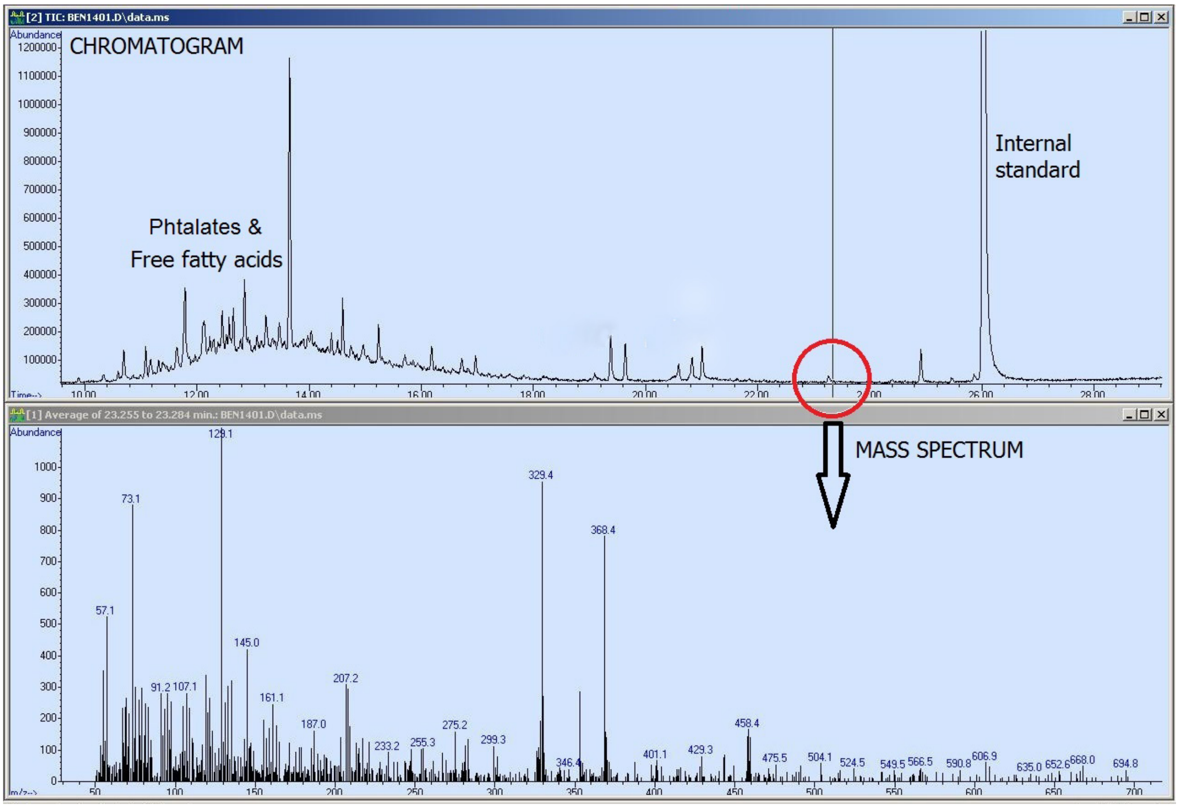


**Figure 4.2** Highly contaminated profile of one vessel from Benson. The mass spectrum is produced for the peak representing cholesterol (circled, at c.23mins) in the chromatogram. Cholesterol is identified by its characteristic ion fragments 129, 329, 368 and 458.

### *4.3.2 Compound-specific carbon stable isotope analysis by GC/C/IRMS*

In the first chapter, I mentioned the stable isotope work that has been carried out on skeletal remains from the British Mesolithic and Neolithic. Similar analyses can be performed on a host of different archaeological remains, including organic residues. Most chemical elements occur naturally as two or more stable isotopes. Different isotopes of the same element vary in the number of neutrons in the atom’s nucleus, and this affects the mass number (protons + neutrons) of the atom. Each isotope of the same element will have the same number of protons and electrons. Isotopes with more neutrons are heavier than those with fewer neutrons, and as elements undergo natural processes the lighter isotopes tend to become enriched as organisms shed the heavier isotopes through, for example, digestion. The most common stable isotopes of carbon are $^{12}C$ and $^{13}C$, with six and seven neutrons in the nucleus respectively. Carbon famously occurs as an unstable, radioactive isotope as well ($^{14}C$) but it is the stable isotopes that are of interest here. A carbon or nitrogen stable isotope value is the ratio between the two stable isotopes detected in an archaeological sample, such as bone. This ratio is expressed as $\delta^{13}C$, and the value itself denotes the deviation from an established standard.

Compound-specific carbon stable isotope analysis by Gas Chromatography/Combustion /Isotope Ratio Mass Spectrometry (GC/C/IRMS) enables us to further characterise the $C_{18:0}/C_{16:0}$ fatty acids that are retrieved through GC/MS. We have seen that the chemical constituents of food undergo some alteration and decay during cooking and deposition in the ground. In this context, it is relevant that the stable isotope ratios of the lipids and other chemicals will remain unchanged during cooking and diagenesis breakdown (Brown and Brown 2011: 197). In other words, the decay product retains the same $\delta^{13}C$ value as the parent molecule. Accordingly, compound-specific carbon stable isotope analysis of the most abundant fatty acids in a lipid residue may provide more specific information about the origins of detected lipids. This line of enquiry thus complements information provided by GC/MS analysis. For example, the $C_{18:0}/C_{16:0}$ ratio in itself provides a rough measure of whether a ruminant or monogastric animal was the source of the foods cooked in a pot since the $C_{18:0}$ fatty acid is more prevalent in ruminants (more on this below). However, this estimation depends on comparable rates of decay of the two fatty acids. In addition, this fatty acid ratio may indicate a ruminant-source food but it does not tell us whether the food was consumed as dairy or meat. The distribution of triacylglycerols in a well-preserved lipid extract may shed some light on this, but preservation of intact TAGs is exception rather than norm. Measuring the carbon stable isotope ratios within individual molecules by GC/C/IRMS is a significant additional technique. The technique is best applied when the overall lipid yield is high enough (>100µg/g) and disturbance from contaminants is low or non-existent.

The technique is capable of distinguishing between milk and adipose fats since the mammary gland of ruminants synthesizes its own $C_{16:0}$ fatty acid but not the $C_{18:0}$ versions (Brown and Brown 2011: 198). In contrast, adipose tissue synthesizes both $C_{16:0}$ and $C_{18:0}$ fatty acids. This process involves an isotopic shift that results in an enriched $\delta^{13}C$ value compared to both dietary carbon and the carbon synthesized in the ruminant gut (ibid.).

The absolute carbon stable isotope ratios of the major saturated fatty acids in milk are determined by the animal's diet, but the $\delta^{13}C$ of the $C_{18:0}$ fatty acid is always lighter than the $\delta^{13}C$ of the $C_{16:0}$ fatty acid (Craig et al. 2005: 885). The difference is expressed as $\Delta^{13}C$, which denotes:

$$\Delta^{13}C = (\delta^{13}C_{18:0}) - (\delta^{13}C_{16:0})$$

The $\Delta^{13}C$ value of ruminant milk fat is considered to fall between -3.3 and -7‰. The value is negative since it is depleted in the heavier $^{13}C$ isotope and enriched in the lighter $^{12}C$ isotope. This $\Delta^{13}C$ value is what distinguishes milk fat from ruminant adipose fat ($\Delta^{13}C$ between -3.3 and -1‰) and non-ruminant fat ($\Delta^{13}C$ between -1 and 2‰) (ibid. 886; Craig et al. 2004). The stable isotope studies of bone collagen do not utilise these same parameters since the fractionation and deposition pathways are very different. In contrast to the bone collagen value, a lipid residue is of the food itself. In the laboratory, the lipid extract is generally obtained in the same way as for GC/MS analysis. Thereafter, protocols may vary but extracted lipids are often analysed as fatty acid ester derivatives (FAMEs). In compound-specific isotope ratio instruments (in contrast to 'bulk' samples) the compounds are separated in the GC and then combusted into $CO_2$, $H_2O$, and $NO_2$. The gases are again separated and the GC column bleeds them into the mass spectrometer, which is equipped with a device for isotope ratio measurements (Pollard et al. 2007: 169). Output plotted against the known reference values for porcine, ruminant adipose, and ruminant dairy fats. Reference values are also known for aquatic products (Craig et al. 2007) and certain plant oils (Steele et al. 2010).

The possibility to detect milk, beef, and pork fats by GC/C/IRMS has motivated a series of studies of pottery residues from Britain (e.g. Dudd and Evershed 1998; Copley et al. 2005; Mukherjee et al. 2008) and elsewhere in Europe (e.g. Craig et al. 2007, 2011). The picture thus emerging for the British Neolithic is that milk is evident in pottery from the Early Neolithic onwards (Copley et al. 2005). Later on, cattle meat and milk seem especially associated with Peterborough Ware, whereas Grooved Ware pottery tends to yield signals of pig fat (Dudd et al. 1999; Mukherjee et al. 2008). That is not to say that each ceramic currency can be neatly associated with a favourite food; a much more complex picture emerges when we examine the details. Moreover, we have not yet analysed sufficient quantities of sherds and sites to assess whether these are real trends. Nonetheless, the data raises interesting questions and I return to it in later chapters.

## 4.4 Lipid residues

### *4.4.1 Lipids as biomarkers*

The biomarker approach is currently the most widely applied in interpretation of data generated by GC/MS analysis of lipid extracts (Pollard et al. 2007: 148; Evershed 2008: 897). A complimentary approach is to compare fatty acid ratios to one another and make inferences based on known degradation rates of different compounds (Eerkens 2005). Lipids are present in nearly all foodstuffs and individual lipids are shared by many plants and animals (Barnard et al. 2007: 42). Fatty acids are particularly widespread as most fats and oils are made up of a relatively restricted range (Evershed 1993: 84). Biomarkers cannot usually be linked to species, and the use of data obtained by GC/MS or related analyses relies on interpretive decisions. A biomolecule may constitute a 'biomarker', although the terms are not interchangeable. In archaeology, a biomarker is defined as an organic residue substance that resulted from human activity in the past (Evershed 2008: 897). In addition, organic remains that are not left by humans but can provide information about human life are included. As humans are not the only producers of biomarkers, the concept is used in neighbouring disciplines such as organic geochemistry (where it originated) and palaeontology (Evershed 1993: 78). Moreover, it is not exclusive to the study of lipids since biomarkers have been defined within each class of biomolecules. Fragments can sometimes be diagnostic biomarkers when the intact biomolecules or compounds do not survive (Evershed 2008: 897; Pollard et al. 2007: 148). For example, amino acids may point to an original presence of proteins, and free fatty acids of fats. Biomarkers are commonly made up of organic structures, compounds, or mixtures of compounds that have been defined as indicative of – in the case of pottery – certain food groups or food processing activities.

The lipid group is itself heterogeneous and its boundaries and definitions are not fixed. Indeed, an 'intuitive' understanding of the term is shared by those involved in research (Christie 1989: 11). Structurally, lipids are so varied that no generalisations can be made (Brown and Brown 2011: 55). Instead, a definition based on physical properties is recurring, even though a diverse range of compounds that otherwise have little in common are thus assigned to the lipid group (Bonfield 1997: 23). In this definition, lipids are those compounds that are soluble in organic solvents like chloroform and acetone, but insoluble in water. Accordingly, the lipid group includes fats, waxes, oils, resins, and steroids

(Brown and Brown 2011: 54). They comprise mainly carbon, hydrogen, and oxygen, and they fulfil a variety of vital roles in all plants and animals. For example, fats store energy and enable uptake of crucial vitamins in animals, while the waxes of plant leafs and bird feathers protect them against predators and environmental stress (ibid.). Due to their hydrophobicity, lipids are less susceptible to structural modification and degradation in the burial environment than other classes of biomolecules such as proteins and nucleic acids (Evershed 1993: 77; Eerkens 2007: 90). Their insolubility in water also enhances archaeological potential since they are less prone than other compounds to dissolve and travel with groundwater, thereby increasing the likelihood that lipids extracted from archaeological residues are in-situ. Nonetheless, the lipid biomolecules detected by GC/MS cannot be promptly translated into specific food species or groups. Some of the complexities involved in using this kind of data have been tackled by scientists, while others have yet to be better understood.

### *4.4.2 Contamination*

When we aim to detect the foods and commodities that were put into pottery vessels by humans in the past, any lipids that may have become trapped within the ceramic matrix during pottery manufacture, burial, or post-excavation treatment are contaminants. Exposed surface residues may be the most vulnerable to the effects of contamination (Evershed 2008: 904) although contaminants are also frequently absorbed into the ceramic fabric. In terms of manufacture, the possibility that lipids native to the ceramic raw materials would have remained within the walls of the fired pot can probably be ruled out (Eerkens 2007: 91). Fatty acids that may have been originally present in clay or inclusions would not survive firing at a minimum of 500˚C (ibid.; Rye 1981: 25). Secondly, naturally occurring soil lipids are unlikely to disturb the biomarker profile obtained from ceramics. Decomposing organic matter in the soil releases various compounds, but their influence on ceramic lipid composition is negligible (Heron et al. 1991). Comparisons between lipid extracts obtained from the interior and the exterior surfaces of sherds point in the same direction (Eerkens 2007: 91). Finally, many of the contaminants that may be introduced during post-excavation handling and in the laboratory can be identified as such. For example, synthetic substances such as phthalate plasticisers are commonly detected. Phthalates are added to plastics to enhance properties like elasticity and transparency, and are likely to have entered the ceramic during storage in plastic bags. Phthalates are typically present in extracts produced in the laboratory since exposure to solvents such as chloroform separates them from the source polymer (Gross 2004: 275).

Organic compounds introduced by handling without gloves can be more difficult to distinguish from ancient ones. Squalene is a triterpenoid hydrocarbon that is naturally present in adult human skin (Nicolaides 1974: 20). It is not stable enough to survive in the ground and when encountered it is an indicator of modern, rather than ancient, fingerprints (Evershed 1993: 90). Cholesterol is also naturally present on the surface of human skin, and when detected in a lipid extract it may have derived from a variety of animal sources including ancient meals and the hands of an archaeologist. Therefore, cholesterol is not usually considered ancient when it co-occurs with squalene (ibid.). These types of contaminants are relevant in this study, since all sampled sherds were obtained from assemblages that had undergone several post-excavation stages. Other compounds that may enter the ceramic matrix during post-excavation handling come from skincare products such as moisturizers and sunscreen lotions. Such products may contain any number or combination of a vast variety of chemical compounds and mixtures, including some of our archaeological biomarkers. For instance, ingredients such as beeswax, tallow, and plant essential oils are sometimes used in skincare products and may introduce wax esters, mono-, di-, and triglycerols, and terpenes respectively.

The issue of absorption of skin lipids and other modern contaminants into ceramic has recently been investigated under laboratory conditions (Dimc 2011). In this experiment, four blocks of clay were tempered and fired to replicate prehistoric ceramics. Three of them were then extensively, moderately, or minimally handled with bare hands. Ceramic powder for GC/MS analysis was then obtained according to standard protocol from three locations on each block, so that the surface, the middle, and the innermost millimetres were represented and the distribution of absorbed compounds in the ceramic could be assessed (ibid. 33). Results show that the ways in which the four blocks were handled (or not handled) directly impacted on the quantities and concentrations of lipids detected. The results from the moderately handled block are perhaps the most interesting since it was treated to mimic the procedures of traditional post-excavation, macroscopic pottery sherd analysis. The samples from this block indicate that even though the highest amount of absorbed contaminating compounds was obtained from the surface millimetre, the inner two millimetres still yielded significant amounts. In other words, modern contaminants are likely to be present in lipid extracts even when the surface millimetre of the sherd is discarded (ibid. 38-39). Squalene and cholesterol dominated the extract profiles, but plasticisers and polyunsaturated fatty acids were also detected. Perhaps most notable is the presence of biomarkers that are routinely interpreted as derived from aquatic animal or vegetable foods in the moderately handled block, namely phytosterols, isoprenoid fatty acids (4,8,12-TMTD, 2,6,10,14-TMPD, and 3,7,11,15-TMHD), and waxes (ibid.). Finally, since squalene and cholesterol were seen to migrate at least 3mm into the ceramic, the possibility cannot be ruled out that fingerprints of past makers and users of the pottery have been absorbed through exterior surfaces (ibid. 45).

In light of this, interpretation of compounds present must be undertaken on basis of the entire chromatographic profile of each extract. In other words, the mere presence of a particular compound may not suffice, but relative quantities and combinations of compounds must be assessed. For example, a series of specific biomarkers ought to be present in order for us to infer processing of aquatic foods, whereas each of them on their own may have different implications. Similarly, singular mid-chain ketones indicate original presence of waxy vegetable foods, whereas a series suggests repeated heating of terrestrial animal products.

### *4.4.3 Modification and decay*

Issues to do with molecular degradation and structural modification are also critical. Conditions such as temperature, pH, and degree of wetness of the burial environment will affect the rate of decay of lipids trapped in archaeological contexts (Evershed 1993: 77). Different kinds of lipids are unequally resistant to decay, mainly depending on the degree of saturation. Unsaturated fatty acids are more vulnerable than saturated ones to microbiological degradation and chemical reactions, and polyunsaturates are the least stable. Post-depositional decomposition can occur by, for example, hydrolysis and oxidation. However, such processes do not necessarily reduce their potential as biomarkers. The biomarker approach has in some cases been expanded to include recognition of altered molecular structures. This depends on the degree to which researchers have been able to characterise decay or alteration pathways (Evershed 2008a: 900). Sometimes, the ways in which people in the past prepared their foods produced compounds more stable than their precursors, thus enhancing the possibility of their detection in archaeological residues (ibid. 901). However, the impact of bacteria that feed on organic residues is a vexing and relatively under-studied problem (Eerkens 2007: 91).

The prospect of identifying bacterial contamination by characteristic biomarkers, such as some branched chain fatty acids, is hampered by the frequency of these markers in many other organisms as well (Evershed 1993: 88). Bacterial and microbial attack on organic residues in archaeological contexts is a likely theme of further experimental study.

In sum, potential biomarkers must see through an obstacle course in order to be detected by the archaeologist (Barnard et al. 2007: 56). Trapped within a ceramic matrix, they must maintain a recognisable structure in the ground for millennia and behave in the desired way during extraction and preparation procedures in the laboratory. Ultimately, they must travel through and emerge from the GC column and ionise in the MS. Inevitably, some are lost along the way (ibid.). Others probably never migrated into the vessel wall at all. It is not entirely clear what stage of vessel use the recovered lipids represent. It is conceivable that major binding sites in the ceramic became occupied during the first cooking episode. Alternatively, each use of the vessel may have resulted in partial replacement of lipids. Recovered signals thus represent the final uses of the pot (Craig et al. 2004: 630). A third possibility is that the lipid profile obtained from absorbed residues represents an amalgamation of many cooking events, with emphasis on the first few uses (Barnard et al. 2007: 56; Eerkens 2007: 91). Another experimental study has demonstrated that lipid signals from pottery do indeed reflect each cooking event and foodstuff, but with no particular emphasis on first or last uses (Evershed 2008b: 34). This caveat brings us to consider more fully the role of material culture in culinary practices, and thus in residue formation.

## 4.5 Interpreting the data

The following outline is not an exhaustive description of biomarkers frequently encountered in archaeological residues obtained from pottery vessels. Instead, it reflects the results of GC/MS analysis described in the next chapter.

### *4.5.1 Milk and meat*

Lipid residues from archaeological materials frequently contain free fatty acids indicative of degraded animal fat. Most fats consist of triacylglycerols (TAGs) made up of three fatty acids linked by ester bonds to a glycerol. Free fatty acids are released when the original fats decay. Intact TAGs are occasionally detected in absorbed residues from ceramics although, more commonly, degraded fats are found. Diacylglycerols (DAGs) are glycerols with two fatty acids present, while monoacylglycerols (MAGs) have lost all but one of the fatty acids. However, intact TAGs are somewhat more resistant to decay than the DAGs in which the breakdown process has already begun. Detection of DAGs or MAGs in lipid extracts from pottery indicates that the fats are indeed ancient.

The ratio of palmitic (hexadecanoic acid, $C_{16:0}$) to stearic (octadecanoic acid, $C_{18:0}$) acid provides a measure of the relative contributions of different food groups, since fat of terrestrial animals contain higher concentrations of stearic acid than the oils and waxes of plants and aquatic animals do. When the $C_{18:0}/C_{16:0}$ ratio suggests a significant contribution of terrestrial animal fat, the source may be narrowed down further. An indication of whether lipids of ruminant or non-ruminant animals contributed to the residue is provided by the ratio between the $C_{17:branched}$ and $C_{18:straight}$ fatty acids. Due to bacterial activity in the ruminant gut, fats from ruminant animals like cattle, sheep, and goat contain more branched fatty acids and odd-carbon number fatty acids than fats from mono-gastric animals such as pigs and horses. This ratio also gives a rough estimation of the relative contributions of adipose and dairy fats. In addition, the distribution of TAGs can shed light on the contribution of ruminant-derived fats. A distribution wide enough to include short-chained compounds (i.e. with 40-54 carbon atoms in the chain as opposed to 46-54) implies a ruminant source. If the short-chain TAGs (40-44 carbons) predominate, dairy fats are a likely origin. These kinds of calculations rest on the inference that fatty acid distributions detected in lipid extracts to a reliable extent mirror the constituents of fats and oils that once migrated into the ceramic matrix. However, fatty acids of different carbon lengths may behave differently during food processing and in the burial environment. For example, stearic acid is somewhat less soluble in water than palmitic acid (Pollard et al. 2007: 152). Equally, short-chained TAGs are more susceptible to degradation than the long-chained, and a lack of the former cannot be taken at face-value. In other words, a ruminant source cannot be ruled out. In the absence of intact TAGs, inferences based on constituents of degraded fats must be used with caution, if at all (ibid.). At present, the most reliable means of distinguishing ruminant from non-ruminant fats and milk from meat is by GC/C/IRMS.

Ketones constitute a diverse class of organic compounds that contain a double-bonded carbonyl group that is attached to two hydrocarbon groups (Brown and Brown 2011: 293). When ketones with 29-35 carbon atoms were first identified in lipid extracts from archaeological pottery they were interpreted as indicative of leafy vegetables since they are a component of the epicuticular waxes of higher plants (Evershed et al. 1991). A precursor-relationship between these long-chain compounds and the leaf waxes of vegetables like cabbage, leek, cauliflower, and broccoli was proposed (ibid. 541). However, a few years later the application of compound-specific stable carbon isotope analysis to lipids in residues cast some doubt on this interpretation (Evershed et al. 1995; Raven et al. 1997). Determination of the $\delta^{13}C$ values by GC/C/IRMS of the major ketone components of lipid extracts from pottery showed that they were too elevated to match those of the vegetables, and alternative sources of the long-chain ketones were sought. The similarity in $\delta^{13}C$ values and often joint occurrence of series of long-chain ketones and $C_{18:0}$ and $C_{16:0}$ fatty acids led to the suggestion that the former are a product of pyrolysis of free fatty acids or TAGs. In other words, long-chain ketones that are analogous to those found in the epicuticular waxes of leafy vegetables are formed when acyl lipids are heated to at least 270˚C (Evershed 2008a: 901). The formation of long-chain ketones by pyrolysis is facilitated by the presence of inorganic salts and/or the fired clay walls of the pottery vessel itself (Evershed et al. 1995: 8878; Raven et al. 1997: 275-6). However, the temperatures required for this to occur are higher than those achieved through boiling. Frying is more likely to achieve the temperatures involved in ketone-series formation. A leafy vegetable-origin for long-chain ketones encountered in residues cannot be ruled out, but current knowledge suggests that when a series of ketones is present they are more likely to represent thermally-induced changes in saturated fats derived from, for example, pig and cattle. Moreover, the long-chain ketones detected in archaeological residues are probably the accumulated product of repeated heating and cooling of absorbed fats, as the single such use of a vessel would not result in appreciable quantities (Raven et al. 1997: 283; Brown and Brown 2011: 130).

### *4.5.2 Aquatic foods*

Another set of compounds that is indicative of the heating of food is the ω-(o-alkylphenyl)alkanoic acids with 16 to 22 carbon atoms. They are formed when polyunsaturated fatty acids are heated in excess of 270˚C (Hansel et al. 2004: 3000; Brown and Brown 2011: 130). A fatty acid with more than one double bond is polyunsaturated. It is typically liquid rather than solid at room temperature. Polyunsaturates are divided into ω-3 and ω-6 fatty acids, depending on the position of the double bonds along the carbon chain. They are found in abundance in many marine and freshwater fish and shellfish, marine mammals, and in many seeds and nuts. The $C_{20}$ alkylphenyl fatty acid may also have derived from a terrestrial animal. Unsaturated fatty acids are vulnerable to heat, which is why fried oils and fish may have lost their benign fats. The $C_{16}$, $C_{18}$, and $C_{20}$ alkylphenyl alkanoic acids are formed when foodstuffs that contain the triunsaturated $C_{16:3}$, $C_{18:3}$, and $C_{20:3}$ are heated (Hansel et al. 2004; Olsson and Isaksson 2008: 777). Processing of marine and freshwater animal products has been inferred from the presence of ω-(o-alkylphenyl)alkanoic acids in lipid extracts from pottery vessels found in Brazil (Hansel et al. 2004) and South Africa (Copley et al. 2004). The breakdown pathway from polyunsaturated aquatic oils to the more stable ω-(o-alkylphenyl)alkanoic acids has been further defined through recent experimental work (Evershed et al. 2008).

The isoprenoid compounds phytanic acid (3,7,11,15-tetramethyl hexadecanoic acid or TMHD), pristanic acid (2,6,10,14-tetramethyl pentadecanoic acid or TMPD), and 4,8,12-trimethyltetradecanoic (TMTD) acid are found in many marine mammals and oily fish. However, they are also constituents of milk and adipose bovine fat. Ideally, phytanic acid and 4,8,12-trimethyltetradecanoic (TMTD) acid should both be present in a lipid extract, along with the $C_{16}$, $C_{18}$, $C_{20}$ and $C_{22}$ alkylphenyl alkanoic acids, in order to securely infer processing of fish (Olsson and Isaksson 2008: 777). Cholesterol, the main animal sterol, may also help distinguish aquatic foods from plants.

### *4.5.3 Plants for food and fuel*

Plants are the most elusive type of food in an organic residue. Plant oils are generally more vulnerable than most animal fats, for a number of reasons. For example, short-chained fatty acids are more likely to break down during burial. At the same time, a lack of biomarkers for many plant fats impedes their detection (Steele et al. 2010). Fatty acid ratios (such as a high relative proportion of $C_{16:0}$) may indicate that a plant oil was originally present, but it is difficult to assess which type of plant it may have been. Similarly, the most frequent of the known plant biomarkers, β-sitosterol, is present in all plant lipids. Ergosterol, on the other hand, may offer more detailed information as it has recently been defined as a biomarker for fungi that indicates alcohol fermentation in ceramic vessels (Isaksson et al. 2010). Recent experimental GC/C/IRMS work that established reference $\delta^{13}C_{18:0}$ values for certain plants improves the fate of those plant oils in archaeological residues (Steele et al. 2010). The study by Steele et al. shows that the analysed plant oils have different isotopic signatures than the groups of animal fats (porcine, ruminant adipose, milk, and aquatic fat) that are commonly targeted by IRMS. The analysed plant oils cluster in an area between the reference-values for ruminant and porcine fats, although values in this area are generally interpreted as mixtures of animal products. The plant oil isotopic signatures cast doubt on such interpretations, and further research is needed (ibid. 3483).

In anticipation of better understood plant isotopic signatures, there are additional biomarkers that point to plant processing in pottery. Epicuticular wax of leafy vegetables can enter the ceramic matrix, as we have seen above in relation to ketones. Wax is also biosynthesised by certain insects, most famously bees. Waxes are less susceptible to degradation than TAGs because wax esters are less likely to react with water in the burial environment (Pollard et al. 2007: 156). However, plant waxes occur in lipid extracts from pottery in much smaller quantities than meat fats due to differential concentrations of lipids in the source organisms (Evershed 2008b: 30). Leaf waxes of plants can be distinguished from plant and animal adipose tissue by their characteristically long and even-numbered carbon chains (>20 carbon atoms) and by the presence of long-chain alkanols. Apart from these constituents, waxes may also contain secondary alcohols, alkanes, and ketones. Series of long-chain alcohols and fatty acids are indicative of plant foods processing. Traces of wax are sometimes assigned to the Brassica genus of plants, which includes a variety of crops of major dietary significance to humans for their edible roots, stems, flowers, buds, leaves, and seeds (Rakow 2004: 3). A wide range of domestic species have been developed from the wild Brassica progenitor species, including cabbages (B. oleracea) like cauliflower and broccoli (ibid. 7, 11). Domestic and wild variants of turnip (B. rapa and B. rapa campestris) are also widespread in Europe.

Terpenes constitute another class of biomolecules that is frequently found in ceramic residues. This is a very large group of mainly plant-derived compounds, comprising several thousand known varieties. Terpenes are useful as biomarkers since many of them are produced exclusively by one or a few species, and they are the main constituents of tree resin and many derivatives thereof (Brown and Brown 2011: 59). Moreover, di- and triterpenes have been extensively studied and reference knowledge is robust enough to sometimes assign those found in archaeological residues to botanical species (Evershed 2008a: 898). Terpenes may become trapped in a ceramic matrix as smoke or soot during use of wood as fuel in domestic hearths. Resins and their by-products may also have been introduced to the ceramic fabric as sealants and adhesives. Derivatives of terpenes constitute another vast and variable group of organic compounds that may be detected in archaeological residues, including the aforementioned terpenoids phytanic acid and pristanic acid. Finally, the $C_{18}$ alkylphenyl fatty acid is not only a by-product of heated polyunsaturated fats, but it may also indicate use of vegetable oil. If $C_{18}$ is found to be the dominant alkylphenyl fatty acid, oily plants such as nuts and seeds are likely candidates.

## 4.6 Reconstructing vessel use

### *4.6.1 Food residues from pottery*

Organic residues are found in a variety of contexts and they relate to many different kinds of activities. Traces of foodstuffs in ceramic vessels are amongst the most commonly analysed, but other important parent materials include textiles, coprolites, soils, and stone artefacts (Evershed 2008a: 903). Not all residues relate to foodways – biomarkers of, for example, dyes and adhesives have also been identified (Regert et al. 2003: 1627). Ceramic residue studies generally target either carbonised surface residues or the biomolecules and compounds that were absorbed into the walls of unglazed vessels during cooking or commodity processing. The rarest kind of residue is the in-situ content itself. Examples include ancient Egyptian oil jars with original content still inside (Evershed 2008a: 903) and the intact Bronze Age pots with nettle stew found at Must Farm in Cambridgeshire (Knight 2012: 9). The invisible, absorbed kind of residue is the most frequently occurring. As we have seen, the entrapment of lipids within the pores of a ceramic fabric may help to preserve them in the burial environment. Experimental work has demonstrated that the greatest accumulations of absorbed lipid residues are found near interior surfaces of the upper body, neck, and rim of vessels, which seems intuitive since fat and oil rise to the surface during cooking (Charters et al. 1993; Evershed 2008b: 29). I return to this in the next chapter, since the dataset produced here indicates that lipid accumulation and deposition are more complex and contextually varied processes.

Ceramics are not used exclusively in food and drink processing, but the three main categories of pottery use offered by Rice (1987: 207) are relevant within the culinary domain. First, pots are ideal for storing dry foods while keeping moisture out. Second, the archaeological record offers many examples of pottery being used for containment and transportation of liquid substances such as wine, oil, and honey, most conspicuously in the Roman world (e.g. Peacock and Williams 1986). Third, the processing of food with or without heat is the use-category that we most strongly associate with ceramic vessels (Rice 1987: 209). Each category of use may result in deposition of lipids within the ceramic matrix, although the heating of food is most likely to do so. The duration and/or frequency of vessel use will also impact on residue formation (Regert 2007: 63). Ceramic cheese-strainers are an example of vessels in which only brief contact between foodstuff and ceramic did not, in most cases, result in lipid deposition (ibid.). 'Empty' vessels are nearly always present among those sampled for lipid residue analysis. According to one recent estimate, around half of sampled sherds yield no lipids at all (Pollard et al. 2007: 149). Another educated guess is that absorbed organic residues are likely to survive in over eighty per cent of 'domestic cooking pottery' (Evershed 2008a: 904). The lack of absorbed residues in a vessel may be a result of unfavourable preservational conditions, but it may also tell us something about its use-life. Aspects of manufacture and deposition of the barren vessels are as significant as those of the lipid-yielding ones.

#### *4.6.2 Situating food residues*

Data obtained by GC/MS and associated techniques cannot be interpreted in isolation from the context of the residue. Circumstances that should be taken into account include details of the parent vessel – its form, size, fabric, decoration or lack of it, and the feature in which it was deposited. The context is also the other artefacts and ecofacts recovered from that feature, the site itself, and the contemporary landscape. Evershed (2008a: 912) suggests that 'background archaeological information' is necessary to not only decide on the most appropriate analytical protocol, but also to support the results of residue analysis. For instance, in studies of animal source foods, only the main domesticated species of the relevant region need be considered. However, if reference species are limited to those plants and animals that we already *know* were present, we must ask what new information residue analysis really brings to the table. In my view, lipid residue analysis of ceramics relates more than anything to the use of ceramics as culinary tools. It tells us as much – if not more – about the use of pottery as it does about food. We saw in the first chapter that terms such as diet and cuisine are not interchangeable. Information obtained by lipid residue analysis of pottery may certainly have wider economic implications (e.g. Copley et al. 2005), but we cannot reconstruct diet on this basis alone. For example, many kinds of food were probably never stored or cooked in ceramic vessels. Vegetables, nuts, fish, and meat may be roasted, dried, pickled, and eaten raw or with minimal alteration (Isaksson

2010: 9). Moreover, a range of organic-material implements and containers do not survive. We have access only to those aspects of food preparation that involved pottery.

Ceramic residues, then, tell us something about cookery practices. A standard dictionary offers a threefold definition of cookery: it refers to the art, practice, and science of cooking and food processing. Thus foodstuffs, material culture, and the actions of consumers and cooks are brought together. We have seen that the study of pottery as culinary tools overcomes the 'contradiction' between the consumer and the consumed in the archaeological record. It also brings together topics that are commonly studied in isolation by ceramicists, including manufacture, style, exchange, use, and discard. Yet different uses of pottery places specific demands on vessel size, form, and ceramic paste ingredients (Rice 1987: 209). Object biographies are often far more complex than our classic analytical divide between manufacture and use would suggest. Repair-holes on pottery and re-use of broken vessels suggest that breakage may not be the end of a pot's life (Hurcombe 2007a: 536). Questions of style, production and distribution have for at least half a century dominated studies of British Neolithic pottery (e.g. Piggott 1954; Peacock 1969; Whittle 1977; Herne 1988; Cleal 2004). An integrated approach to lipid residue analysis enables us to consider jointly the topics of manufacture and consumption. We may ask, for example, whether the intended use of a vessel determined how it was made, and vice versa. In this way, the social contexts of food and pottery begin to emerge.

## 4.7 Conclusion

Meal ingredients chosen by prehistoric consumers, the leftovers thereof in ceramic vessels, and the fragile biomolecules detected in modern laboratories are not alike, and the steps between them can be precarious. Before we can begin to refill the pottery vessels we must try to unravel the 'mass of contributing factors' (Bonfield 1997: 2) that are involved in residue formation. The activities that we aim to reconstruct are to do with the use of ceramic vessels, yet aspects of pottery manufacture, breakage, deposition, post-excavation treatment, and laboratory procedures also impact upon the character of the lipid extract that we *may* obtain. Known biomarkers include both original and altered molecular structures, as most compounds derived from meal ingredients undergo some form of alteration during vessel use and/or burial. Therefore, we can identify not only the food groups that were utilised but also, in some cases, the manners in which they were prepared. As many food species have archaeological biomarkers in common, the entire lipid profile must be considered before an interpretive decision can be made. Traceable food groups include dairy and meat of ruminants, meat of other terrestrial animals, marine and freshwater oily fish and shellfish, and oily plants like vegetables and nuts. However, not all foods are equally represented in these datasets. Plants are especially elusive, given their generally low lipid content and vulnerable lipid components. Ultimately, ceramic lipid residue data tells us more about cookery than it does about diet. The primary context is not only the food that was eaten, but also the vessel in which it was prepared. This joint approach brings together aspects that are commonly disconnected for analytical purposes.

# 5. Results

## 5.1 Introduction

This chapter presents results of lipid residue analysis by GC/MS and GC/C/IRMS of pottery from the four Upper Thames pit sites introduced in previous chapters. Absorbed lipid residue data is likely to reflect the last few uses of a pottery vessel (Craig et al. 2004). Therefore, further insights into domestic activities can be generated by targeting pottery from pit sites. However, the evaluation of output of lipid residue analysis is based on a series of interpretive decisions akin to those made during preparation of an excavation report or traditional visual examination of artefacts. I described this process in general terms in the previous chapter. The procedures followed in this project are described here, along with a few issues specific to this dataset. For example, contamination is inevitable when working with sherds from the site archives. The contaminations encountered here and the way in which they were approached in interpretation of GC/MS output are discussed. Results are presented and situated within the parent vessels and their context. Pot and feature (F) numbers correspond to those assigned in each published report. In addition, each sampled sherd was given a sample number (figs. 3.6 to 3.9). Lastly, the results of GC/MS and GC/C/IRMS analysis of each assemblage are brought together. I discuss the foodstuffs detected and the ways in which pottery was used to process them, and issues to do with representativeness are highlighted. The dataset illustrates that special care may be needed when sampling Neolithic pottery for lipid residue analysis, not only because it fragile but also because of how it was originally used.

## 5.2 Sherd selection strategy

Sherds were for selected for lipid residue analysis from the site archives. Sherds may also be selected in the field during excavation, and both approaches have advantages and disadvantages. Sherd selection in the field reduces the risk of modern contaminants entering the ceramic fabric or surface residue, although contaminants may be introduced also when obtaining in-situ sherds under controlled conditions (Papmehl-Dufay 2006:

163). On the other hand, lipid residues from sherds that have been handled extensively almost certainly contain modern contaminants along with prehistoric lipids. Sherd selection from the archive nonetheless benefits from a firmer understanding of the assemblage and its context(s). Accordingly, the sherd selection strategy applied to all four pottery assemblages was primarily focused on the reconstructable, diagnostic component. This approach enables integration of lipid signals with stylistic and technological aspects like vessel form and size. Each pottery style represented within the four assemblages was included in the body of samples. The vessel-based approach generates a sample comprising mainly rim- and upper body-sherds, which is considered favourable as the greatest accumulations of absorbed lipids are likely to be found in the walls of the upper part of the vessel (Charters et al. 1993). In addition, six body-sherds were selected. Beyond the vessels themselves, contextual considerations were made and, where possible, sherds from pits that were radiocarbon dated and/or contained ecofacts were favoured. However, any sherd selection strategy can only be taken as far as the material itself will allow. The assemblages were recovered in various states of preservation; the pottery from Cotswold Community is the most fragmented. In addition, each assemblage includes a few vessels represented only by extensively decorated and/or small, diagnostic sherds that could not be sampled for destructive analysis.

## 5.3 Method

### *5.3.1 Lipid extraction and derivatization*

Powdered ceramic was ground off the interior surface using a tile grinder at low speed. Drill heads were cleaned in chloroform in an ultrasonic bath for 15 minutes between each use. The surface millimetre of ceramic was discarded to reduce contamination. Ceramic powder (0.5-1.5g) was transferred quantitatively to extraction vessels before addition of an internal standard (20μg hexatriacontane, $C_{36}$) and a solvent mixture of chloroform and methanol (2:1, v:v). The lipid component was separated from the ceramic matter through sonication (2x15mins). Samples were left to settle for 12 hours and centrifuged (30mins at 3000 rpm). Clear extracts were transferred to vials and dried under a gentle stream of nitrogen, before treatment with bis(trimethylsilyl)triflouracetamide containing 10% (v) chlorotrimethylsilane (South Stoke samples: 60µl; Benson, Horcott Pit and Cotswold Community samples: 100µl) at 70°C for circa 20 minutes to produce trimethylsilyl derivatives. Reagents were evaporated with nitrogen and the derivatized extracts were re-dissolved in 400µl *n*-hexane prior to injection.

### 5.3.2 GC/MS procedure

Analysis was performed on a HP 6890 Gas Chromatograph equipped with a SGE BPX5 capillary column (15m x 220µm x 0.25µm). The injection was done by a pulsed splitless (pulse pressure 17.6 Psi) technique at 325°C by a *Merlin Microseal™ High Pressure Septum* by means of an *Agilent 7683B* auto-injector. The oven was programmed with an initial isothermal of 2 minutes at 50°C, followed by a temperature increase of 10°C per minute to 350°C, finished by a 15 minutes isothermal at this temperature. Helium as the carrier gas was held at a constant flow of 2.0 ml/minute.

The gas chromatograph was connected to a HP 5967 Mass Selective Detector via a 360°C interface. The fragmentation of the compounds was done by electric ionization (EI) at 70 eV. The temperature at the ion source was 230°C. The mass filter was set to scan the interval of m/z 50 to 700, providing 2.29 scans per second. The temperature at the mass filter was 150˚C. The data was processed using the MSD Chemstation™ software.

### 5.3.3 Quantitation and interpretation of GC/MS output

Each chromatogram was manually integrated in order to separate prehistoric lipids from modern contaminations prior to quantitation. Quantitation was achieved through an equation in which the combined areas of peaks deemed to represent prehistoric molecules are compared with the peak area of the internal standard and the quantity of ceramic powder. Quantities given denote micrograms (µg) of prehistoric lipids to each gram of ceramic powder. Extraction was successful in all samples, although not all extracts contained prehistoric lipids.

Peaks (molecules) were identified by their mass spectral ion fragmentation profiles, characteristic in their derivatized and ionized form of a series of compound classes (table 2). The biomarkers thus sought were free fatty acids ($C_{12-20}$), monoacylglycerols, diacylglycerols, triacylglycerols, wax residues (long-chain fatty acids and alkanols), long-chain ketones, sterols, isoprenoid fatty acids (4,8,12-TMTD, 2,6,10,14-TMPD, and 3,7,11,15-TMHD), ω-(o-alkylphenyl) fatty acids, and di- and triterpenes. Some compound classes, such as the ω-(o-alkylphenyl) fatty acids, are typically present in such low quantities that ion chromatograms must be produced in order to detect them (fig. 5.1). This was achieved by targeting and extracting views of the characteristic ion fragments listed in Table 2.

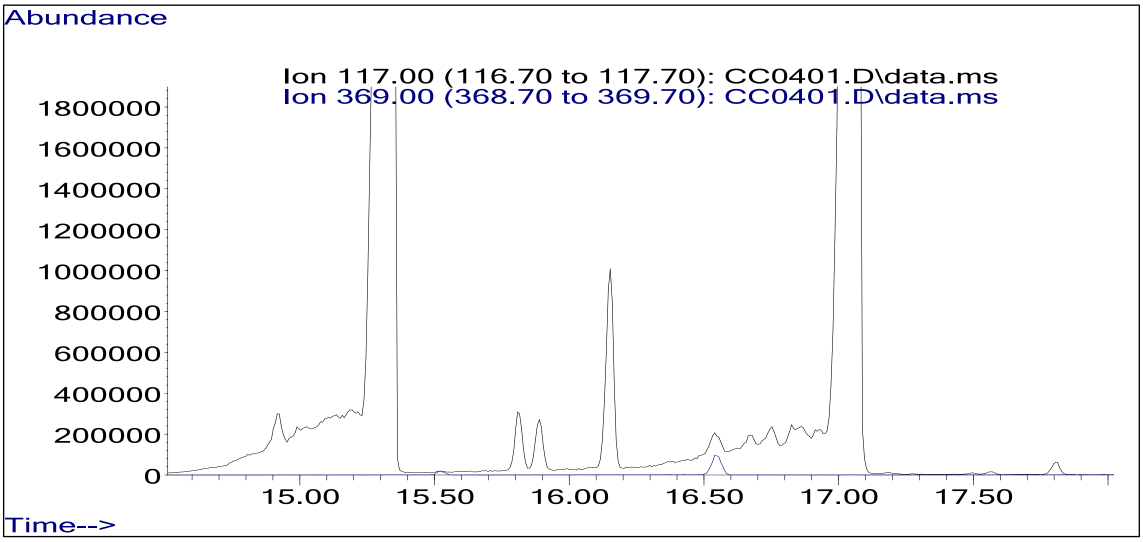


**Figure 5.1** Close-up of an ion chromatogram; the minor peak at 16.50mins is the 3,7,11,15 TMHD fatty acid (phytanic acid). The more prominent peaks are the C16:0, C17br, C17:0, and C18:0 fatty acids.

| **Compound class** | **Mass peak (*m/z*)** |
|---|---|
| Free fatty acids* | *m/z* 73, 117 |
| Monoacylglycerols* | *m/z* 343, 371, 399, 427 |
| Diacylglycerols* | *m/z* 127, 385, 399 |
| Triacylglycerols* | *m/z* 127, 155, 183, 211, 239, 267, or *m/z* 439, 467, 495, 523, 551, 579 |
| Alkanols* | *m/z* 75, 103 |
| Alkanes* | *m/z* 57, 71, 85 |
| Cholesterol* | *m/z* 329, 368, 458 |
| β-sitosterol°* | *m/z* 486, 396, 357 |
| Campesterol°* | *m/z* 472, 343, 382 |
| Stigmasterol°* | *m/z* 484, 255, 394 |
| Ergosterol* | *m/z* 337, 363, 468 |
| Long-chain ketones | *m/z* 239, 267 |
| 4,8,12-TMTD | *m/z* 117, 313 |
| 2,6,10,14-TMPD | *m/z* 117, 355 |
| 3,7,11,15-TMHD | *m/z* 117, 369 |
| ω-(o-alkylphenyl) fatty acids | *m/z* 105, 305, 333, 361, 389 |
| Diterpenes | *m/z* 239, 314, 372 |
| Triterpenes | *m/z* 189 |
| Wax esters | *m/z* 257 |
| Squalene | *m/z* 69 |
| Phthalates | *m/z* 149, 167 |

**Table 2.** Ion fragments used in identification. *detected as TMS derivatives; °phytosterol

Three individual fatty acids were quantified to generate the fatty acid ratios that yield information complementary to the biomarker approach. As we have seen, the ratio of stearic acid (octadecanoic acid, $C_{18:0}$) to palmitic acid (hexadecanoic acid, $C_{16:0}$) is used to distinguish terrestrial animal fats from those of aquatic animals and vegetables, since the former produce more stearic acid. A stearic to palmitic acid ratio lower than 0.5 is considered indicative of major contributions of lipids from vegetable foods and/or aquatic animals to the extract. Higher values signalling substantial input of terrestrial animal fats warrant further comparison of the $C_{18:str}$ and $C_{17:br}$ fatty acids. Ratios higher than 0.02 indicate that ruminant animal products contributed to the lipid extract.

### *5.3.4 Note on contamination*

Contaminants may enter the ceramic matrix at different stages and with varying degrees of impact on the substances that are archaeologically interesting. Those lipids that stem from pottery use in the past are for simplicity referred to here as ‘prehistoric’. For this study sherds were obtained from the site archives and, therefore, contaminants introduced through handling and storage are considered along with soil lipids that may have migrated into the ceramic during burial.

Phthalates were detected in all extracts, albeit in several cases only in trace amounts. They are readily identified as they peak at *m/z* 149 (base peak of dialkyl phthalates) and *m/z* 167 (Gross 2004: 505; Sparkman et al. 2011: 274, 394). GC column bleed is another common and easily recognisable contaminant (Sparkman et al. 2011: 274) that was present in a few of the extracts. Squalene was detected in the extracts of just over half of the sampled sherds. The squalene signal dominates a few of the barren or near-barren extracts, but it is negligible in those extracts with high overall lipid yields. The same is true for the synthetic contaminants. Thus the chromatographic profiles of extracts carrying high quantities of prehistoric lipids are not generally skewed by the presence of modern contamination. Curiously, a large, well-preserved, and skilfully decorated sherd of a Peterborough Ware vessel from Horcott Pit (Pot 9/HP04) yielded an unusually strong signal of squalene. It may have been passed around among excavators, finds specialists, and perhaps visitors. This particular sherd certainly highlights the perils of sampling for residue analysis in the archive and among attractive, diagnostic rim-sherds.

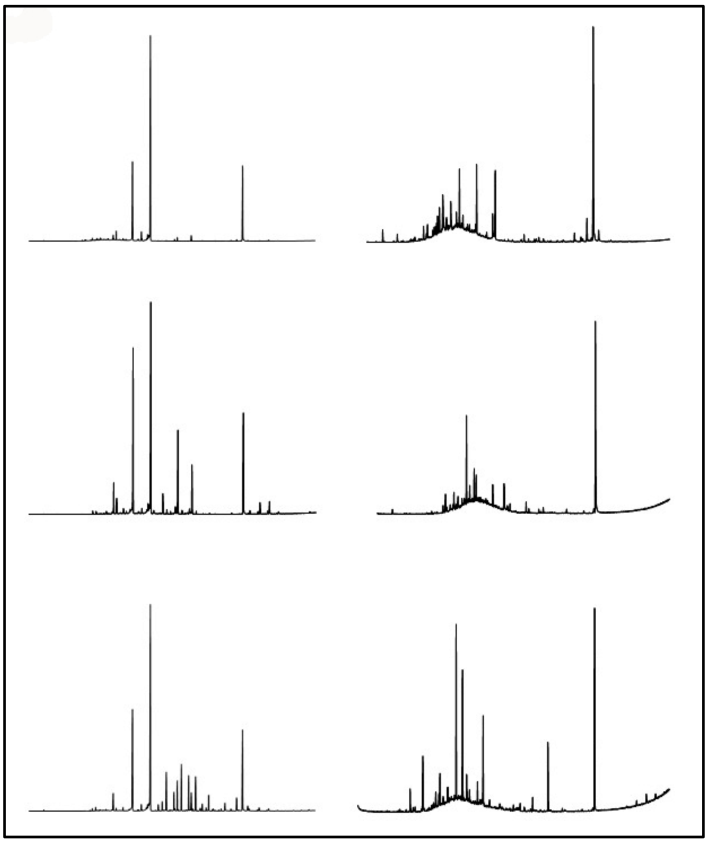

**Figure 5.2** Negligibly contaminated profiles with tidy peaks from Benson (left: BEN11, BEN16, BEN18) and ‘humpbacked’ profiles of highly contaminated lipid extracts from Horcott Pit and South Stoke (right: HP03, HP08, SS07).

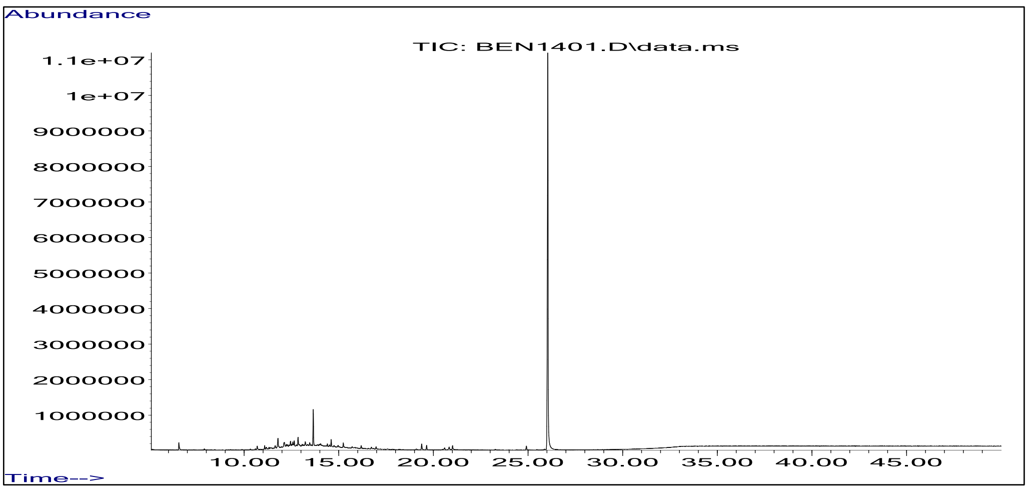


**Figure 5.3** The lipid extract from Benson pot 15 (BEN14) contained over 80% contaminants: the peak just before 14mins is a phthalate. C16 and C18 monoacylglycerols and long-chain alkanols (around 20mins) may also be modern contaminations.

Cholesterol was present in the majority of samples from South Stoke and Horcott Pit, and at somewhat lower frequency at the other two sites. Cholesterol is treated with caution due to the frequent presence of squalene, even though it may be indicative of animal foods processing. The recent experimental study of fingerprint absorption by Dimc (2011) demonstrates that skin lipids may be absorbed several millimetres into the ceramic, and the cholesterol may in some cases result from prehistoric (rather than modern) fingerprints. At the same time, cholesterol was not present in the barren extracts from Cotswold Community and Horcott Pit, yet they too would have been handled in prehistory. Overall, the cholesterol biomarker is approached on a site by site basis. The other organic compounds that may conceivably be contaminants but are routinely interpreted as prehistoric (i.e. phytosterols, the isoprenoid fatty acids 4,8,12-TMTD, 2,6,10,14-TMPD, and 3,7,11,15-TMHD, and waxes – Dimc 2011: 39) are approached in view of the rest of the chromatographic profile. Similarly, monoacylglycerols were interpreted as prehistoric only when a series of two or more were present in conjunction with other prehistoric lipid compounds.

Contamination in two extracts from St Helen's Avenue, Benson, was quantitated in order to define descriptions of 'highly' and 'negligibly' contaminated extracts[1]. The extract from pot 15 (BEN14) was highly contaminated; 83% of 21.2μg/g of compounds detected were clear contaminations (fig. 5.3). In this case, phthalates produced fairly tidy peaks, although highly contaminated chromatographic profiles may also display a more pronounced 'hump' between 10 and 20 minutes (fig. 5.2). In contrast, pot 21 from Benson (BEN18) contained less than 2% contaminations. This extract yielded a much higher quantity of prehistoric lipids than BEN14, but they contained similar quantities of contaminants (14.6μ/g and 17.6μ/g). In other words, in the extracts with high lipid yields the background noise produced by contaminants is not loud enough to distort the prehistoric lipid signals. These are the negligibly contaminated extracts. The highly contaminated extracts tend to contain only minor quantities of lipids that may be prehistoric. These are difficult to assess and are not given much interpretive weight.

[1] Quantitations for contamination assessment were made on basis of the entire profile of detected compounds in both extracts, whereas Table 3 lists lipid quantities excluding contaminations.

### 5.3.5 GC/C/IRMS procedure

Eight of the extracts produced in the GC/MS analysis were further analysed by GC/C/IRMS, including one from Benson (BEN07), three from Horcott Pit (HP01, HP02, HP06) and four from South Stoke (SS04, SS05, SS09, and SS10). Methylation and additional GC/MS analysis of these extracts were undertaken to ensure quality and concentration of lipids. Accordingly, a portion of the lipid residues was hydrolysed in 1ml 0.5NaOH in methanol at 70°C for 1 hour to release bound fatty acids. Once cooled, the mixture was neutralised using 6M HCl. The free fatty acids were extracted using n-hexane three times and the extracts were then recombined and dried under nitrogen. Methyl esters were produced as the dry free fatty acids were treated with Borontriflouride (25%) in methanol at 70°C. The fatty acid methyl esters were extracted using n-hexane and dried under nitrogen. To enable correction for the added carbon during methylation pure fatty acid standards were treated in parallel with the samples and analysed for their $\delta^{13}C$ both derivatised and underivatised. Prior to the compound-specific stable carbon isotope analysis the methylated residues were analysed by GC/MS using identical chromatographic conditions as for the following GC/C/IRMS.

The GC/C/IRMS analysis was performed at the Stable Isotope Laboratory at Stockholm University. It was performed on a Thermo Delta V mass spectrometer with Trace GC and IsoLink reactor system for the conversion of fatty acid methyl esters to $CO_2$. The GC oven was temperature-programmed with an initial isothermal of 2 minutes at 50°C, followed by a temperature increase of 30°C per minute to 130°C, followed by a temperature ramp 4°C per minute to 230°C. Finally, the temperature was increased by 15°C per minute to 325°C and this temperature was maintained for 7 minutes. The Trace GC was equipped with a DB5 capillary column (60m x 0.32mm x 0.25µm). $CO_2$-pulses injected via a ConFlo were used as measurement references. The $CO_2$-pulses were calibrated against a certified fatty acid methyl ester standard of known $\delta^{13}C$ and this was done individually for both $C_{16:0}$ and $C_{18:0}$. Carbon isotopic values were expressed in per mil (‰) relative to the Pee Dee Belemnite (PDB) standard. The standard deviation of the measurement on the $C_{16:0}$ was 0.3‰ and 0.8‰ for the $C_{18:0}$ fatty acid methyl ester.

**Table 3.** (opposite) Results of lipid residue analysis by GC/MS (tr.: trace amount; TAG: triacylglycerols; DAG: diacylglycerol; MAG: monoacylglycerol; sq.: squalene; long-ch.: long-chained; DT: diterpene; TT: triterpene; FA: fatty acid; *additional analysis by GC/C/IRMS). A $C_{18:0}/C_{16:0}$ value of >0.5 indicates terrestrial animal fat. A C17:br/C18:0 value of >0.02 indicates ruminant animal fats.

| | qty: | | | | | | | sterols: | | waxes: | | | long-ch. | isoprenoids | | ω-(o-alkylphenyl) FA:s | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **sample** | **µg/g** | **C18/C16** | **C17br/C18** | **TAGs** | **DAGs** | **MAGs** | **sq.** | **chol.** | **phyto-** | **alkanols** | **fatty acids** | **ester** | **ketones** | **TMPD** | **TMHD** | **C16** | **C18** | **C20** | **DT** | **TT** |
| **CC01** | 712 | 2.05 | 0.0035 | | | M16-18 | | X | | | C22-26 | | C31-35 | | | | X | | | |
| **CC02** | | | | | | | | | | | | | | | | | | | | |
| **CC03** | | | | | | | | | | | | | | | | | | | | |
| **CC04** | 1855 | 0.97 | 0.051 | | D30-34 | M14-18 | | X | X | C22-30 | | | C29-35 | | X | | | | | X |
| **SS01** | | | | | | | | | | | | | | | | | | | | |
| **SS02*** | 191 | 0.26 | | | | M16-18 | X | X | | C22-30 | | | | | X | | | | | |
| **SS03** | 0.74 | | | | | | X | X | | | | | | | | | | | | |
| **SS04*** | 1691 | 0.39 | 0.07 | T42-54 | D30-34 | M14-20 | X | X | | C24-26 | | | | | X | | | | | |
| **SS05*** | 1487 | 0.33 | 0.07 | T42-52 | | M16-18 | X | X | X | C24-30 | | X | | | X | | X | | tr | |
| **SS06** | 43 | 0.71 | 0.02 | | D34 tr | M14-18 | X | X | | C22-28 | | | | | | | | | X | |
| **SS07** | 25 | | | | | M16 tr | X | | | C24-30 | | X | | | | | | | | |
| **SS08** | 1991 | 0.62 | 0.047 | | | M16-18 | X | X | | C22-30 | | | | | X | | | | | |
| **SS09*** | 180 | 0.59 | 0.029 | | D32-36 | M14-18 | | X | X | C24-28 | | | C31-35 | | | | | | | |
| **SS10*** | 105 | 0.58 | 0.04 | | D30-34 | M14-20 | | X | | C22-26 | | | | | | | | | X | |
| **SS11** | 2.6 | | | | | | | X | | | | | | | | | | | | |
| **HP01*** | 833 | 1.43 | 0.017 | | | M16-20 | X | X | | | C22-26 | | C29-35 | | X | | | | | X |
| **HP02*** | 1873 | 1.16 | 0.024 | | D34 | M14-18 | X | X | X | | C22-28 | | C29-35 | | X | | X | tr | | |
| **HP03** | 67 | 1.12 | 0.1 | | D32-36 | M14-18 | | X | X | C22-30 | C22-26 | | C29-35 | | | | | | | |
| **HP04** | 32.5 | | | | | M14-20 | X | X | X | C22-26 | | | | | | | | | | |
| **HP05** | 43.5 | 1.26 | | | | M16-18 | | X | X | C24-28 | | | C29-35 | | X | | | | | |
| **HP06*** | 699 | 2.19 | 0.022 | | D34-36 | M16-18 | X | X | | C24-30 | C22-24 | | C29-35 | | X | | | | | tr |
| **HP07** | 102 | 0.68 | 0.21 | T42-54 | D30-38 | M14-20 | | X | | C24 | C22-28 | | C29-35 | | | | | | | |
| **HP08** | 24 | | | | | M14-18 | X | X | | C22-24 | | | | | | | | | | |
| **HP09** | | | | | | | | | | | | | | | | | | | | |
| **HP10** | | | | | | | | | | | | | | | | | | | | |
| **BEN01** | 2 | 0.66 | | | | M16-18 | X | | | | | | | | | | | | tr | |
| **BEN02** | 22 | 1.66 | 0.014 | | | M14-18 | X | | | | C22-26 | | C31-35 | | | | X | | tr | |
| **BEN03** | 55 | 4.08 | 0.015 | | | M16-18 | | | | C24-28 | | X | C31-35 | | | X | | | | |
| **BEN04** | 16 | 2.17 | 0.008 | | | M16-18 | tr | | | | | | | | | | | | | |
| **BEN05** | 98 | 2.06 | 0.005 | | | M16-18 | | | | | C22-30 | | C31-35 | | | | | | | |
| **BEN06** | 2 | 0.85 | | | | M16-18 | | | | | C22-28 | | | | | | | | | X |
| **BEN07*** | 518 | 2.61 | 0.01 | | | tr | | tr | | | C22-30 | | | | X | | X | | | |
| **BEN08** | 59 | 2.24 | 0.008 | | | M16-18 | tr | | X | | C22-26 | | | tr | X | | | | X | |
| **BEN09** | | | | | | | | | | | | | | | | | | | | |
| **BEN10** | | | | | | | | | | | | | | | | | | | | |
| **BEN11** | 323 | 3.215 | 0.012 | tr | D30-34 | M14-20 | X | X | tr | C24-30 | | | C29-35 | | X | | | | | X |
| **BEN12** | 10 | 0.52 | | | | M16-18 | tr | tr | | C24-28 | | | | | | | | | | |
| **BEN13** | 38.5 | 0.715 | | | D30-34 | M14-20 | tr | X | | C24-28 | | | | | | | | | | |
| **BEN14** | 3.7 | 0.514 | | | | M16-18 | X | X | | C23 | | | | | | | | | | |
| **BEN15** | 6 | | | | | M16-18 | tr | X | | | | | | | | | | | | |
| **BEN16** | 565 | 1.264 | 0.015 | T42-52 | D32-36 | M14-18 | | X | | | C22-26 | | | | tr | | | | | |
| **BEN17** | 93.4 | 3.45 | 0.042 | | tr | M16-18 | tr | X | X | C24-28 | | | C29-35 | | tr | | | | | X |
| **BEN18** | 730 | 2.34 | 0.11 | T42-54 | D30-34 | M14-20 | | tr | | C22-28 | C22-30 | | C29-35 | | | | | | | |
| **BEN19** | 12.8 | 1.525 | 0.07 | | | M16-18 | X | X | X | | | | | | X | | | | | |

| Sample | FAME | mean | std.dev. | n | $\Delta^{13}C$ |
|---|---|---|---|---|---|
| BEN07 | C16 | -28.07 | 0.38 | 3 | -3.46 |
| | C18 | -31.52 | 0.67 | 3 | |
| HP01 | C16 | -29.29 | 0.80 | 3 | -3.80 |
| | C18 | -33.09 | 0.54 | 3 | |
| HP02 | C16 | -29.32 | 0.30 | 3 | -2.95 |
| | C18 | -32.26 | 0.51 | 3 | |
| HP06 | C16 | -29.36 | 0.25 | 4 | -3.15 |
| | C18 | -32.51 | 1.32 | 4 | |
| SS04 | C16 | -30.88 | 0.26 | 3 | -5.00 |
| | C18 | -35.88 | 1.00 | 3 | |
| SS05 | C16 | -30.64 | 0.49 | 3 | -3.72 |
| | C18 | -34.35 | 0.49 | 3 | |
| SS09 | C16 | ns | ns | 1 | |
| | C18 | ns | ns | 1 | |
| SS10 | C16 | ns | ns | 1 | |
| | C18 | ns | ns | 1 | |

**Table 4.** Stable carbon isotope values obtained by GC/C/IRMS analysis (FAME: fatty acid methyl ester; std. dev.: standard deviation)

## 5.4 South Stoke, Oxfordshire

### *5.4.1 The South Stoke sample*

A minimum of ten vessels could be reconstructed from the pottery assemblage that was retrieved from seven of the Early Neolithic pits at South Stoke (Edwards et al. 2005: 235). Sherds from eight of the ten reconstructable vessels were selected for lipid residue analysis. Two samples were taken from the large lugged bowl Pot 6. In addition, sherds from two unassigned vessels were selected, including one body sherd (SS09) and one rim-sherd (SS10). With the exception of one of the unassigned vessels (SS09) and the second sample from Pot 6, all samples were taken from interior surfaces of rims or of sherds conjoining rims. In total, eleven lipid extracts were produced from ten South Stoke vessels. Four of the extracts were further analysed by GC/C/IRMS. The set of samples represents each of the seven pit features that contained Early Neolithic pottery, including the three radiocarbon-dated features**.**

### *5.4.2 Results from South Stoke*

Prehistoric lipids were detected in extracts from six of the ten selected vessels, indicating that dairy and probably plant foods were processed. Intact triacylglycerols are present in two extracts and their wide distribution (T42-52) points to dairy fats. In one of them (SS04) the breakdown process of fat is clearly discernable as series of diacylglycerols (D30-34) and monoacylglycerols (M14-20) are also present. This is a medium-sized, undecorated closed bowl (Pot 5) with a simple rim, made of a flinty and sandy fabric. The stearic/palmitic acid ratio is relatively low (0.39), which is likely to reflect processing of plant foods that would have brought down this ratio. The presence of long-chain alkanols ($C_{24\text{-}26}$) and phytanic acid supports this interpretation. Plant foods such as grain would have absorbed fat during cooking, thus the high quantity of lipids extracted from the vessel walls points towards high overall fat content. Compound-specific carbon stable isotope analysis by GC/C/IRMS of the major fatty acids supports a dairy source; the extract from Pot 5 yielded a $\Delta^{13}C$ value of -5.00. This is the strongest dairy signal among the eight extracts that were analysed by GC/C/IRMS. The presence of ruminant fats is further supported by the high (0.07) ratio of $C_{18:0}$ to $C_{17:br}$.

The extracts obtained from Pot 6 (SS05, SS08) yielded remarkably similar profiles to that from Pot 5 (SS04), although the plant foods-signal is somewhat stronger. No diacylglycerols were present, instead a plant sterol (β-sitosterol), a longer series long-chain alkanols ($C_{24\text{-}30}$), and the $C_{18}$ ω-(o-alkylphenyl) fatty acid were detected. Samples were taken from two locations on Pot 6, which is a large, closed-form undecorated vessel with solid lugs and an uneven, sagging rim. One sample (SS05) was taken just beneath the rim and the other (SS08) further down on the body of the vessel. Comparison between the two extracts reveals some variation; both yielded very high amounts (1487μg/g and 1991μg/g) and similar repertoires of absorbed lipids, but they appear better preserved in the rim-sherd extract. Here, intact triacylglycerols (T42-52) are present, and the $C_{18:0}$ fatty acid is not as prevalent compared to the more vulnerable $C_{16:0}$ and $C_{17:br}$ fatty acids. In other words, the signal of dairy and vegetable foods is stronger in the upper part of the vessel. That may be because the lower parts of the vessel were frequently exposed to high temperatures when foods were cooked over a fire, resulting in accelerated degradation of the more vulnerable fatty acids. Alternatively, the lipids found to have been absorbed around the rim of the vessel may be traces of cream. The $\Delta^{13}C$ value of -3.72 from the rim-sherd extract (SS05) confirms the presence of milk. Raw (unpasteurised and un-homogenised) milk naturally separates in room temperature and cream collects on the surface. The strong dairy-signal from the rim-sherd probably reflects that milk was kept in this large vessel, with fat collecting at the top. The difference between the two extracts from this vessel also illustrates that poorly preserved dairy lipids may be interpreted as fat from muscle meat.

Plant foods are more probable candidates than aquatic foods in these extracts given the presence of other plant foods-indicators such as phytanic acid and phytosterol. The ω-(o-alkylphenyl) fatty acids can point towards input of lipids from aquatic foods if a series of them are detected (Olsson and Isaksson 2008: 777). Here, only the $C_{18}$ ω-(o-alkylphenyl) fatty acid, which occurs naturally also in oily plants such as nuts, was present in the rim-sherd extract of Pot 6. Large numbers of hazelnut shell fragments were found in all Early Neolithic pit features at South Stoke, and hazelnuts may have been among the ingredients of meals cooked in this vessel.

The extract from Pot 2 (SS02) contained a lower quantity of prehistoric lipids (191µg/g) but the profile largely echoes those of Pots 5 and 6. It too is likely to have contained plant foods; the stearic/palmitic acid ratio is low (0.26). No strong indicators of dairy fats are present since the $C_{18:0}$ to $C_{17:br}$ could not be assessed and tri- or diacylglycerols were not preserved. This undecorated pot is the largest of the reconstructable vessels with a rim diameter of 270mm and a straight, deep profile. Notably, it was burnished on the exterior surface and smoothed and wiped on the interior. This thorough surface treatment would have closed some of the pockets and may have resulted in less extensive deposition of lipids in the ceramic matrix.

The remaining three lipid-bearing vessels from South Stoke yielded marginally stronger signals for processing of meat from terrestrial animals. They were recovered from three separate pits (F5027, F5015, and F5031) and include a closed bowl (Pot 8/SS06), an unassigned body-sherd (SS09) and an unassigned rim-sherd that may derive from a cup or small bowl (SS10). The stearic/palmitic acid ratios range from 0.58 to 0.71, which along with the presence of di- and monoacylglycerols suggest animal source foods. Two of them (SS09, SS10) yielded ratios of $C_{18:0}$ to $C_{17:br}$ that are lower (0.03 and 0.04) than in Pots 5 and 6 (described above) but still above the threshold for a ruminant source. No further clues could be detected through compound-specific carbon stable isotope analysis by GC/C/IRMS of the SS09 and SS10 extracts. The lowest $C_{18:0}$ to $C_{17:br}$ ratio (0.02) is from Pot 8 and may indicate a non-ruminant, or a mixture of ruminant and monogastric animal foods. The lipid concentration in this extract is significantly lower (43µg/g) than in the other five extracts that contained prehistoric lipids. It also displays the highest stearic/palmitic acid ratio among the South Stoke samples, which suggests animal food processing. Interestingly, Pot 8 was recovered from the pit (F5027) that contained a more substantial faunal assemblage than any of the others, including three pig bones, four cattle teeth, a cattle femur, and two sheep/goat bones. Stylistically, this vessel is indistinguishable from the others.

Long-chain ketones ($C_{31-35}$), signalling heating of saturated fats are only present in the extract from the unassigned body-sherd SS09. Unfortunately, the form of this vessel is not known, although the fact that a series of ketones was found only in a body-sherd extract suggests that fats would have accumulated and repeatedly heated in the lower parts of cooking vessels. Cooking with high temperatures are also indicated at South Stoke by charred residues on a few undiagnostic body-sherds from pit 5026 and possibly also by the oxidised cores of many sherds.

Three extracts (SS01, SS03, and SS11) were empty or contained very low quantities of lipids that in the absence of the major saturated fatty acids are interpreted as contaminations. One extract (SS07) contained a slightly higher quantity (25µg/g) of lipids, but the profile comprising squalene, traces of a monoacylglycerols, and intact wax esters also suggests a modern source. The same series of wax esters ($C_{42-46}$) are present also in SS05 and in one of the extracts from St Helen’s Avenue, Benson (BEN03) and is made up of combinations of long-chain alkanols ($C_{26-28}$) and free fatty acids ($C_{16-18}$). The source of this wax is uncertain, although it may be a contaminant from organic matter in the burial environment. Post-excavation contamination of the South Stoke sherds is attested by the presence of squalene in more than half the extracts. However, no squalene was detected in the extracts of the two unassigned sherds (SS09, SS10), which may reflect less extensive handling of these more anonymous components of the assemblage. Cholesterol was detected in all but two extracts but is treated cautiously given the presence of squalene.

In all, five of the six vessels that yielded prehistoric lipids are interpreted as having been used for processing of primarily dairy and plant foods, albeit displaying varying states of lipid preservation. The other (Pot 8) yielded a more mixed signal, probably reflecting some input of non-ruminant meat and less plant foods. Porcine meat is a likely candidate, given that the faunal remains in this feature included pig. The three vessels with the strongest signals of dairy (pots 2, 5, and 6) were all recovered from the same pit feature (F5025). A small closed-form cup (Pot 3) was also found in this pit. The cup is thin-walled and made of a different fabric that included crushed quartzite. The lipid extract from this small cup (SS03) contained no prehistoric lipids, and it is likely that it was used for consumption rather than storage or processing of food and/or drink. According to the excavators, this pit feature was paired with the pit that contained the vessel with mixed-meat lipid signals. In other words, the difference in lipid signals does not correspond with the layout of Early Neolithic features across the site. Instead, there are some correlations between stylistic attributes and lipid content; the four ‘empty’ vessels include the small cup (Pot 3), the only two decorated pots in the body of samples (pots 1 and 9/10), and the only open-form vessel (Pot 11). The latter was also the only non-flinty fabric represented. Five of the selected vessels displayed some kind of surface treatment (primarily smoothing), four of which contained prehistoric lipids. It is possible that surfaces of vessels intended for cooking with heat and/or storage of milk were deliberately treated. Smoothing refers to the rubbing of a tool against the ceramic during the leather-hard stage (once the vessel has dried but prior to firing) thus changing the texture and lustre of the surface (Rye 1981: 89). Finally, the samples from South Stoke indicate that – contrary to perceived wisdom – fats often accumulated at the base and sides of vessels. Other pots were used for holding milk, as seen in the well-preserved dairy lipids accruing along the top.

## 5.5 St Helen’s Avenue, Benson, Oxfordshire

### *5.5.1 The Benson sample*

The body of samples from St Helen’s Avenue in Benson is the largest of this study, reflecting the fact that this assemblage was comparably substantial and well-preserved. A minimum of thirty vessels were reconstructed out of 47 rim-sherds from Neolithic or ‘early prehistoric’ features (Timby 2004: 146). Material from the more broadly dated features was not considered for lipid residue analysis. Instead nineteen out of the twenty-three stratigraphically secure vessels were included. The sample-body represents nine features across the site. Nine vessels were selected from occupation phase 1a, seven from phase 1b, and three from the final, and possibly Middle Neolithic, phase 1c. One of the extracts produced from a phase 1b vessel (Pot 19) was also analysed by GC/C/IRMS. All but three selected vessels were made of flinty fabrics. The remaining three include one large shell-tempered bowl (Pot 19), along with a large quartz-tempered vessel (Pot 1) and a small sandy pot (Pot 6) from two paired pits in the north-east corner of the excavated area.

### *5.5.2 Results from Benson*

Thirteen of the nineteen selected vessels from Benson yielded significant quantities of prehistoric lipids (10μg/g to 730μg/g). A further four extracts contained some amount of absorbed lipids that probably result primarily from modern contamination. Two extracts were devoid of any absorbed lipids. Squalene was present in eleven extracts, often in trace amounts. The sherds were lacquered prior to labelling and several joining fractures are glued together. Care was taken during sampling to avoid such areas and, unexpectedly, the Benson sherds carry less absorbed contaminants than those from Horcott Pit and South Stoke.

Terrestrial animal adipose signals dominate the thirteen extracts with absorbed prehistoric lipids, but dairy foods may have been more prominent among the ingredients than a cursory look would suggest. Stearic/palmitic acid ratios are notably high: 2.1 being the average for the thirteen extracts with prehistoric lipids. In contrast, the seven prehistoric lipid profiles from South Stoke yielded an average stearic/palmitic acid ratio of 0.5. This aspect of the Benson lipid profiles may be partly due to preservational circumstances, which may have prohibited survival of the more vulnerable fatty acids and resulting in somewhat skewed fatty acid ratios. This would explain the dominance of the saturated $C_{18:0}$ fatty acid and the apparent dominance of carcass foods. For example, the ratio of $C_{18:0}$ to $C_{17:br}$ in the extracts of Pots 17 and 21 (BEN16, BEN18) are low enough to indicate monogastric animal fats, yet intact, wide-distribution triacylglycerols indicative of dairy are also present (fig. 5.4). Triacylglycerols are present in two extracts, and further degradation of prehistoric fats is seen as diacylglycerols in at least four. Monoacylglycerols were found in all but the two empty extracts. The GC/MS lipid profile of Pot 19 (BEN07) suggests monogastric animal source foods, but GC/C/IRMS analysis of the $C_{16:0}$ and $C_{18:0}$ fatty acids provided a $\Delta^{13}C$ value of -3.46 indicating a ruminant dairy source. Experiments have demonstrated dairy fats may decay to resemble adipose fat (Dudd and Evershed 1998: 1479).

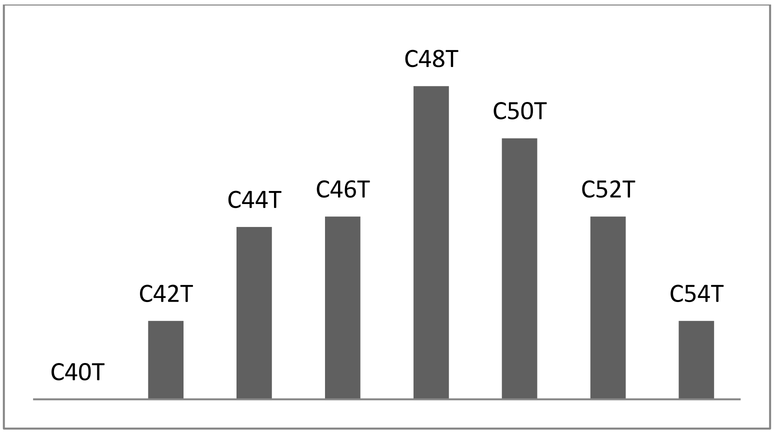


**Figure 5.4** Triacylglycerol distribution in the lipid extract from Pot 21 (BEN18) including TAGs of low molecular weight indicative of dairy fats.

It is conceivable that the sturdy flint-tempered fabrics that make up the majority of this assemblage produced pottery vessels that could be used again and again without breaking. Repeated heating is attested by long-chain ketones (29-35 carbons) in six extracts, and it is possible that cooking accelerated the degradation of more vulnerable fatty acids. Phytanic acid was found in six extracts, and may have derived from dairy as it is present in the ruminant gut through ingestion of plants. In addition to meat and/or dairy, a plant food component is indicated in nearly all extracts with prehistoric lipids; phytosterols are present in four extracts and wax esters are present in all but one of the lipid-bearing extracts.

Variations in pottery styles within this assemblage led the excavators to suggest that we may be dealing with the remains of three more or less distinct occupational phases (Pine and Ford 2004). As discussed in a previous chapter, the chronological implications of this stylistic variation may not be as pronounced as suggested. Radiocarbon dates obtained from two pits that were assigned to the second phase of occupation (1b) yielded a date-range of 3637-3368 BC. With the exception of Pot 11, carinations are slight in this assemblage and it may all belong in the radiocarbon date-range, including the proposed phases 1a and 1c. Nonetheless, the site was probably visited over a longer period of time than the nearby site at South Stoke, which yielded a virtually identical date range. Notably, the longevity of occupation at Benson is not reflected in the use or content of cooking vessels. In other words, there is lipid signal variation among samples but it does not correspond with the rhythms of occupation. For example, intact triacylglycerols indicative of dairy fats are present in two extracts, one of which was obtained from the suggested earliest phase of occupation (Pot 17/BEN16) and the other from the final phase (Pot 21/BEN18).

Instead, there are links between vessel content and formal attributes. The majority of vessels in this assemblage are large or medium-sized closed bowls that were made of dark, flinty fabrics. Absorbed prehistoric lipids were only detected in these kinds of vessels. In contrast, each extract that did *not* yield any prehistoric lipids was obtained from a vessel that in some way deviated; for instance, the two small cups (Pots 6 and 8) did not yield absorbed lipids and may have been used in serving or display rather than cooking or storage of food or drink. They were both made from a ceramic paste that turned light brown/orange in colour when fired, although one was tempered with sand and the other with flint grit. A third vessel made from this orangey clay (Pot 15) did not yield any prehistoric lipids either. Moreover, 'empty' extracts were obtained from two open-form bowls (Pots 12 and 16) that were recovered from two adjacent pits and probably derived from an early visit to the site. Sizeable closed-form bowls made from a dark and gritty ceramic paste appear to have been intended and used for cooking and storage of fatty commodities such as milk. As at South Stoke, it is clear that body-sherds are as conducive to sampling for absorbed lipid residue analysis as rims; two body-sherds were included in the set of samples from Benson (BEN11 and BEN17) and both yielded high amounts of absorbed prehistoric lipids. Again, the only lugged vessel yielded a high quantity (323µg/g) prehistoric lipid. Smaller, open, or lighter-coloured vessels were reserved for serving and display of food and drink. The only exception is an open bowl (Pot 9), in which meat was cooked on several different occasions. This bowl stands out also as it is decorated with faint diagonal incised lines along the top of the rim. Surface treatments have not been recorded for this assemblage and are difficult to assess due to vigorous post-excavation cleaning of sherds.

## 5.6 Horcott Pit, Gloucestershire

### *5.6.1 The Horcott Pit sample*

The Early Neolithic component of the Horcott Pit assemblage comprised almost one kilogram of poorly preserved pottery, representing at least seven Plain Bowl vessels and one minimally decorated vessel (Edwards 2009). Three of the reconstructable Early Neolithic pots could be sampled for absorbed lipid residue analysis, including a body-sherd from a carinated bowl (Pot 2), rim-sherds from another carinated vessel (Pot 4), and a closed globular bowl (Pot 5). The extracts from Pots 2 and 4 were also analysed by GC/C/IRMS. The Middle Neolithic assemblage was larger and somewhat better preserved. A minimum of nineteen vessels could be reconstructed. Three of them were selected for analysis along with four unassigned vessels. One of the reconstructable vessels (Pot 15) was further analysed by GC/C/IRMS. This set of vessels represents seven of the seventeen pit features that contained Early or Middle Neolithic pottery, including both clustered and isolated pits. Unfortunately, a few significant components of the Peterborough Ware assemblage, such as a possible small dish (Pot 14) and sherds of a Mortlake bowl that had been placed so as to line one of the pits (Lamdin-Whymark et al. 2009: 52) were too fragmentary to be included in the sample. The sampled Middle Neolithic vessels include three Mortlake bowls, two probable Fengate bowls, and two Peterborough Ware pots that could not be assigned to a substyle.

### *5.6.2 Results from Horcott Pit*

Six of the ten extracts from the Horcott Pit Early and Middle Neolithic assemblage were found to contain prehistoric lipids. Long-chain ketones are present in all six, indicating that foods were prepared over a fire. Dishes included significant proportions of animal source foods; stearic/palmitic acid ratios are consistently high and degrading animal fats are present within the walls of at least four of the six vessels. $C_{18:0}/C17_{:br}$ ratios cluster around the intermediate value of 0.02 between ruminant and monogastric animal fats, with one exception (0.01 in HP03). Some plant foods input is attested by the presence of wax esters and phytosterols. Phytanic acid was found only in extracts with prehistoric lipids, suggesting not only that plants were among the ingredients but also that this compound is unlikely to result from modern contamination. Phytanic acid may also be derived from the processing of dairy foods since it is present in the ruminant gut. However, it is not necessary to choose between dairy and plant foods in these cases as both are independently represented in the lipid profiles. The former is attested by the presence of intact triacylglycerols (T42-54) in the extract from one of the unassigned vessels and high quantities of absorbed lipids in four extracts. The highest lipid yield was obtained from the rim of Pot 4 (HP02, 1873µg/g), which was a large carinated vessel. The lipid signal indicates dairy and plant foods, although the $\Delta^{13}C$ value of -2.95 also suggests ruminant carcass fats. The $\Delta^{13}C$ from this vessel is the most elevated among all extracts that were analysed by GC/C/IRMS. Another vessel from the same pit cluster (Pot 2/HP01) produced a lipid signal indicative of monogastric animal foods. However, in this case the $\Delta^{13}C$ value of -3.80 provides clear evidence of milk. The fact that this extract came from a body-sherd may explain the discrepancy; we have seen that lipid degradation may be more extensive towards the base of the vessel. Accordingly, the GC/MS lipid profile contains fats that in their present state indicate a monogastric source, whereas stable isotope analysis of the major fatty acids reveals that degraded dairy fat is a more likely candidate. This is because the stable isotope ratios of the lipids remain unchanged during cooking and diagenesis breakdown, which means that the decay product retains the same $\delta^{13}C$ value as the parent molecule. In this case, it suggests that it is not only the pot's content that influences the organic residue data, but also the cookery practices and the way in which the vessel is sampled for analysis. The body-sherd (HP01) from Pot 2 yielded a remarkably high quantity (833µg/g) of absorbed prehistoric lipids. As at South Stoke and Benson, this indicates that cookery practices may not have involved techniques through which fats were primarily accumulated around the internal rims of pottery vessels.

The lipid extract from one Mortlake bowl (Pot 15/HP06) was also analysed by GC/C/IRMS. In this case, the chromatographic profile and the stable carbon isotope values are consistent with one another. Degrading triacylglycerols, phytanic acid, and a high stearic/palmitic acid ratio points to dairy, although the $C_{18:0}$/$C17_{:br}$ ratio (0.22) and the $\Delta^{13}C$ value of -3.15 are intermediate between dairy and ruminant carcass fats. This extensively decorated bowl was used over a fire, as indicated by a series of long-chain ketones ($C_{29\text{-}35}$). Three other Peterborough Ware vessels (pots 9, 11, and one of the unassigned vessels) were recovered from the same pit feature (F5454) and shed some light on occupation activities. Pot 9 is a skilfully made Mortlake bowl which yielded a highly contaminated extract containing a low quantity of indeterminate but possibly prehistoric lipids. The rim and shoulder are decorated in such a way that no undecorated surfaces would be visible from above, and the vessel may have been intended for display (Edwards 2009: 84). In contrast, Pot 11 from the same pit produced a lipid profile indicative of meat and plant processing at high temperatures. This vessel was assigned to the Fengate style of Peterborough Ware on the basis of its collar (ibid.). Finally, the third extract of a vessel from this pit contain the only intact triacylglycerols (T42-52) in the Horcott Pit set of samples, along with degrading fats, long-chain ketones, and the lowest stearic/palmitic acid ratio of the sample set. This vessel is likely to have been used to keep and heat milk as well as plant foods. If vessels that ended up in the same pit had been used alongside each other, this example illustrates that different vessels of the ceramic repertoire served different purposes.

The best preserved lipid profile was obtained from one of the unassigned vessels (HP07). This rim-sherd derives from a poorly made vessel with unevenly applied fingernail impressions. The sample was taken from just beneath the rim, which may explain the absorption of dairy fat and its good preservation. The poorly made vessel may have broken relatively soon after it was made, which would help explain the well-preserved lipid profile. Apart from the six extracts with clear evidence of prehistoric lipids, two additional extracts are highly contaminated and contain lower quantities of lipids which may or may not be prehistoric. Half the extracts from this site were highly contaminated with compounds from plasticisers. No prehistoric lipids were detected in the last two extracts (HP09 and HP10). The two 'empty' extracts were obtained from unassigned Middle Neolithic rim-sherds recovered from the same isolated pit feature in the centre of the excavated area (F5494). The rim and exterior surface are decorated with bird-bone impressions. One of the rims (HP10) is likely to derive from a small vessel, possibly a cup. Given that the cups sampled from the other assemblages in this study were 'empty', it is not surprising that this extract is devoid of prehistoric lipids.

There is no meaningful variation between lipid extracts from Early and Middle Neolithic bowls. The only difference that may be present is to do with monogastric and ruminant source foods; chromatographic profiles of two of three Early Neolithic extracts yielded $C_{18:0}/C17_{:br}$ ratios indicative of a monogastric source, whereas all the Peterborough Ware vessels were probably used to process ruminant animal foods. However, faunal remains suggest that cattle were the dominant species in the earlier period while pig and sheep/goat are present in smaller numbers. The Middle Neolithic faunal assemblage displays a more balanced distribution of cattle and pig. The modest mismatch between the GC/MS data and the faunal remains is due to preservational circumstances; we have seen that the stable carbon isotope values from the Early Neolithic bowls demonstrate that a signal which looks like a porcine source may in fact be degraded ruminant fats. As within the sample from the Benson assemblage, more vulnerable fatty acids indicative of ruminant animal foods have decayed so as to obscure this signal.

All Early and Middle Neolithic pottery fabrics in this assemblage contain shell, albeit in varying proportions. In addition, fabrics were occasionally tempered with small amounts of sand, quartz grit, organic matter, and limestone. All except one would have been fairly large vessels and they all appear to have been smoothed both internally and externally. Notably, the attractive Mortlake bowl mentioned above (Pot 9) has been tempered with a small amount of flint in addition to shell. The clay has fired to a consistent orange colour that also makes this pot stand out. We have seen that this vessel is likely to have been used to serve and display food rather than process it. It may also have been manufactured at a different locale and perhaps by a different potter, given the difference in ceramic paste and the skill with which it has been made. The preference for additional tempering material, along with shell, appears to have increased with time; the Peterborough Ware component contains more than one tempering agent. This may reflect a desire to improve the durability of vessels. Sherds of Early Neolithic bowls are laminated or flaky and may have been more prone to breakage. This variation in pottery manufacture is not mirrored in the lipid residue dataset. More so than at Benson, the Horcott Pit pits produced a pottery assemblage which spans the stylistic changes that we associate with the shift from the Early to the Middle Neolithic. The evidence obtained from absorbed lipid residues in these vessels indicates that cookery practices did not undergo significant changes.

## 5.7 Cotswold Community, Gloucestershire

### *5.7.1 The Cotswold Community sample*

The set of samples from the Cotswold Community assemblage is the smallest in this study. The majority of prehistoric pottery recovered at the site was made of relatively fragile shelly fabrics (Brown and Mullin 2010: 1). A minimum of twelve vessels could be reconstructed from the fragmentary Middle Neolithic assemblage. Of these, only four vessels could be sampled for lipid residue analysis. The sampled vessels were recovered from four separate pit features, and include three sherds associated with or joining rim-sherds of pots 2, 3, and 4. The sherds from P2 may represent the collar of a Fengate vessel, while the other three are probable Mortlake pots. No extracts from the Cotswold Community assemblage were further analysed by GC/C/IRMS.

### *5.7.3 Results from Cotswold Community*

Two of the four extracts from the Cotswold Community Peterborough Ware assemblage contained high quantities of prehistoric lipids while the other two vessels appear not to have been used for cooking or storage of a fat-rich commodity such as milk. Of the former, one (CC01) was obtained from a rim-sherd of a Fengate vessel (Pot 1) and yielded a strong carcass foods signal. A high stearic/palmitic acid ratio (2.05) in combination with cholesterol, long-chain ketones ($C_{31-35}$) and a low ratio of $C_{18:0}$ to $C_{17:br}$ indicate that foods from monogastric animals were processed along with plants. However, the only animal species identified among the faunal remains is cattle (Strid 2010: 209).

The other lipid-bearing extract (CC04) was obtained from a Peterborough Ware bowl (Pot 6) with internal and external whipped cord decorations. This was the only flint-tempered vessel in the reconstructable component of the Middle Neolithic assemblage. It yielded a stronger signal of ruminant animal fat, possibly from dairy, including high ratios of stearic/palmitic acid (0.97) and $C_{18:0}$ to $C_{17:br}$ (0.051), cholesterol, degrading fats seen as diacylglycerols (D30-34) and monoacylglycerols (M14-18), and long-chain ketones with 29 to 35 carbons. Methyl esters of the $C_{16:0}$ and $C_{18:0}$ fatty acids represent decay products of triacylglycerols which have broken down in the glycerol component by soil microorganisms. Plant foods input is indicated by a phytosterol, long-chain alkanol wax esters, and phytanic acid. The extract from Pot 6 also contained a series of pentacyclic triterpenes that may have entered the ceramic as smoke during burning of *Betulaceae* species as hearth fuel. Charcoal from genera of this family of trees and shrubs, including hazel and alder, was recovered from the Middle Neolithic features (Challinor 2010: 196).

As with the other assemblages, no indications of aquatic foods were detected in the lipid extracts from the Cotswold Community pottery. In light thereof, the recovery of a large piece of scallop shell and a possible clam fragments from two paired pits is noteworthy (Powell and Nicholson 2010: 205). However, they need not have been collected for food but are perhaps more likely to have been found among the shore gravels and intended for use as pottery temper (ibid.).

This assemblage appears to have been less handled after excavation than the others. Squalene was not detected and cholesterol was only present in the extracts that also contained prehistoric lipids. Regrettably, not much is known about the form and size of these fragile vessels, and the set of samples is modest. Nonetheless, it is clear that cookery practices at this site are comparable with what is known from contemporary sites in the region. It may be of note that the dairy food signal came from the only flint-tempered vessel in the sample. The vessels made from flinty fabrics are likely to have been brought to the site from elsewhere (Brown and Mullin 2010: 2). This may reflect transhumance, and in that sense the dairy signal is compelling.

## 5.8 Discussion of results

### *5.8.1 Ingredients*

More than half (63%) of the selected sherds were found to contain absorbed lipids related to pottery use in prehistory. This proportion compares well with previous studies of absorbed residues in British prehistoric pottery (Copley et al. 2005b: 897), despite the fact that this study does not specifically target vessels likely to have been used over a fire. Comparison between the four datasets presented above reveals both differences and similarities in cookery practices and pottery use. First, long-chain ketones in lipid extracts from all four assemblages indicate that pottery vessels were used again and again to heat foods over a fire. At each site, firewood would have been collected from shrubby trees in the vicinity, as evidenced both by remains of charcoal found in environmental samples and by the presence of di- and triterpenes among the absorbed lipids. Species such as birch, blackthorn, and hazel provided hearth fuel and terpenoid compounds may have entered the walls of ceramics as smoke from the fires. Hazel was an important source of food as well as warmth, and hazelnuts were probably sometimes added to meals prepared in pottery vessels, as indicated by the $C_{18:0}$ ω-(o-alkylphenyl) fatty acid present in extracts from all sites. However, plant foods are the most elusive among the food groups detected in a lipid extract. The *Brassica* genus of plants, which includes cabbages and many green-leaf vegetables, is a likely candidate when dealing with lipid residues of pottery from historical periods in which their cultivation is documented (e.g. Evershed et al. 1991). In addition to wax esters, the lipid extracts in this study persistently contain the plant food-markers β-sitosterol and phytanic acid. Low quantities of charred cereal grains and sometimes chaff were recovered from several pits, alongside the more ubiquitous hazelnut shell fragments. Cereal species identified include oat, emmer and a free-threshing variety of wheat at South Stoke, emmer wheat at Horcott Pit, and hulled barley at Benson. However, oat and barley were represented by only one single grain each. In addition to the cultivated crops, crab apple fragments and a blackthorn or sloe fruit stone were found in one of the pits at Horcott Pit (Challinor 2009: 112). Lipid indicators of plant foods are more likely than animal fat markers to have entered the ceramic after burial in the ground from decomposing organic matter in the soil. Nonetheless, plants were certainly consumed at these sites. The exceptionally high stearic/palmitic acid ratios recovered at Benson in particular, but also at Cotswold Community and Horcott Pit, may be indicative of leeching of plant oils in the burial environment (Berstan et al. 2008: 704).

Lipid yields also indicate terrestrial animal source foods at all four sites. The animal source foods that were added to such dishes are likely to have included far more than the red cuts of muscular meat that many of us are accustomed to today. Offal items such as liver, heart, kidney, tongue and tripe are unlikely to have gone to waste in prehistoric settings, and they may account for the exceptionally high concentrations of absorbed lipids in many vessels. Some offal foods may also have implications for the techniques we use. For example, how would the cooking of udder in a ceramic vessel impact upon the isotopic and molecular composition of absorbed lipid residues? Unsurprisingly, prehistoric pots often yield lipid signals indicative of mixtures of dairy and carcass fats (e.g. Dudd et al. 1999; Copley et al. 2005). Moreover, it is worth highlighting that we are not, at present, able to distinguish between different ruminant animals. Lipid residue analysis by GC/MS relies on the proportions of certain fatty acids and the distribution of triacylglycerols to infer processing of dairy foods in the pottery vessels. Further analysis by GC/C/IRMS distinguishes between porcine adipose, equine adipose, ruminant adipose, and ruminant dairy fats (Dudd and Evershed 1998; Dudd et al. 1999; Craig et al. 2004). However, the designations made on the basis of stable carbon isotope values of the major fatty acids also leave some scope for interpretation. In northwest Europe today we tend to associate ruminant lipid signals with cow's milk (e.g. Mukherjee et al. 2005: 89; Evershed et al. 2008: 530), but it is worth remembering that sheep/goat remains are widely represented on Neolithic sites. Poorly preserved sheep/goat bones were recovered at each of the four sites targeted here, albeit in lesser proportions than cattle and pig remains. More robust bones of cattle and pig are probably overrepresented in the faunal record at the expense of bone of sheep/goat and other smaller mammals (Evans 2009: 110). With this in mind, dairy foods are evidenced at each of the four sites. Intact triacylglycerols are present in each set of samples, and always with the wide distribution that is indicative of dairy fat (Dudd and Evershed 1998: 1480). The well-preserved traces of dairy fat detected in lipid extracts from rim-sherds probably represent cream that accumulates on the surface. However, that ‘dairy products *must* have been processed in pottery vessels’ (ibid. 1479, added emphasis) is an overstatement. Pottery would have been just one component of material culture repertoires – I discuss this in Chapter 7. Nonetheless, the strong association between ruminant foods and pottery seen in this and other datasets (e.g. Copley et al. 2005b) prompts the question of whether they can be viewed as interdependent components of a Neolithic package. Stable carbon isotope analysis of the major free fatty acids in extracts from Benson, South Stoke, and Horcott Pit confirm that dairy was on the menu. Only one of the six extracts that produced sound $\Delta^{13}C$ values fell beyond the threshold for dairy fat to instead indicate ruminant carcass fat. One other gave an intermediate value between dairy and ruminant carcass fat. Both of these extracts in which the dairy signal is weaker are from the Horcott Pit assemblage. The other four extracts produced $\Delta^{13}C$ values that are clearly indicative of milk. In other words, there is no indication of monogastric source foods in GC/C/IRMS dataset. This not only supports the association between pottery and cattle and sheep/goat, but it also indicate that GC/MS lipid profiles indicative of monogastric foods may in fact be degraded ruminant source foods.

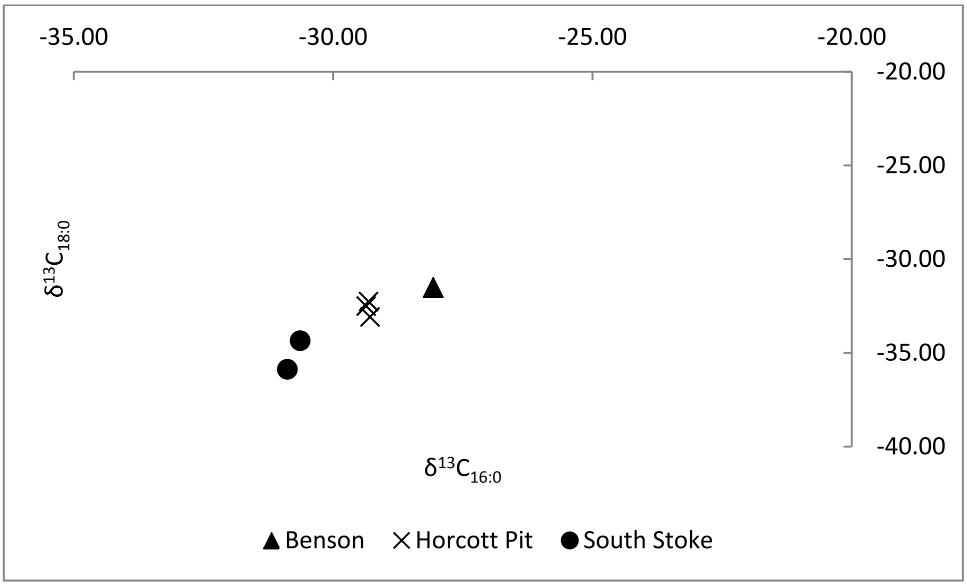


**Figure 5.5** Clustering of $\delta^{13}C$ values of the $C_{18:0}$ and $C_{16:0}$ fatty acids in lipid residue samples

Another notable aspect of the GC/C/IRMS dataset is that, albeit a modest set of samples, the values from different assemblages do not overlap (fig. 5.5). This may reflect, for example, that cattle and sheep/goat grazed in different areas. It also indicates that each community had their own ways of preparing food, even though the ingredients may have been the same. We have seen that ceramic paste recipes varied between communities, and this applies to cookery as well. On that note, we have seen that the sturdiest vessels may produce more degraded lipid signals due to extensive use. If so, the skills and intentions of prehistoric potters directly influence the organic residue data that we generate today. This is another reason why data from food residues cannot be divorced from the vessels themselves. I return to this in Chapter 6.

No indications of aquatic foods were detected. The usual caveat applies: such foods may not have been prepared in ceramic vessels. Their absence in the lipid extracts may reflect spatial and/or seasonal subsistence arrangements (Isaksson 2010: 6). Nonetheless, each site was located near water. We have seen that clusters or pairs of pits represent distinct episodes of occupation. It is difficult to assess the length of such occupations on basis of the material remains, but they may have lasted a few weeks or perhaps a month or two. Similarly, the amount of time that passed between each visit is not known, but people would have returned to such sites many times within a generation. New pits were rarely dug into or immediately adjacent to earlier pits, which indicates that filled-in pits from previous visits were still visible on the ground when inhabitants returned. It is also worth considering that each site comprised pit features that did not contain any broken pottery vessels. Are they the remains of visits during which no vessels broke? At the same time, the fact that a majority of pits at each site *did* contain pottery sherds indicates that episodes of occupation lasted long enough for at least one vessel to break.

### *5.8.2 Patterns of pottery use*

The four assemblages have certain aspects in common. At each site, closed forms are more likely to yield absorbed cooking lipids than open forms. This suggests that closed forms were intended to hold food and liquid, perhaps on journeys as well as during longer pauses in the landscape. Another agreement across the sample sets is that none of the small cups yielded absorbed prehistoric lipids. These more delicate vessels were probably dedicated to serving and consumption, although milk would have left lipid residues. Beer may have been drunk in the small cups, although the alcohol biomarker ergosterol (Isaksson et al. 2010) was not found. Another example of interplay between vessel form and function is provided by the well-made and extensively decorated Pot 9 stands out in the Horcott Pit assemblage. It is likely to have been made by a different potter, and may have been brought to the site from elsewhere. Lipid analysis supports that it was used for display and serving of food rather than cooking. The decoration is best seen from above as it extends about one inch below the rim on the interior surface, and would have framed whatever content the vessel held. The continued appeal of this vessel is evidenced by the unusually strong contamination signal of squalene from human hands.

Other characteristics of the pottery itself help us put the lipid residue data in a regional context. For instance, the flinty ceramic fabrics stand out in the Gloucestershire assemblages, whereas the shelly wares are the exception further west, in Oxfordshire. Some of these distinct vessels may simply have been made at a different locale than the others in the assemblage, although it is more likely that they were exchanged between groups who utilised different clay outcrops and/or different ceramic paste recipes. The content being exchanged would have been as significant as the pot itself, if not more so. Three of the sampled vessels from Benson were made of a non-flinty paste, and two of them did not contain prehistoric lipids. They may have been used to exchange a dry commodity, such as grain. The third is a large closed bowl that was used for processing of meat-rich meals. Cookery practices were consistent during the occupation of each site, even if we take into account the whole series of occupation-episodes represented at each. In other words, no variation in lipid signals can be detected between pit clusters. Evidence of changes in cookery practices is slim also when we take a step back to consider a longer period of time, lasting up to seven centuries from around 3700 BC to the very end of the fourth millennium. Absorbed lipid signals from the earlier bowl pottery are similar to those from the Peterborough Ware vessels that begin to be made just after 3500 BC. The only meaningful variation is between the South Stoke samples and the other three sample sets: lipid signals of meat are more prominent within the latter. This is noteworthy since South Stoke is likely to be the earliest of the four sites, given the absence of chunky forms characteristic of the latter half of the fourth millennium in the pottery assemblage. In addition, the South Stoke pottery resembles that from the Abingdon causewayed enclosure which has recently been dated to around 3600 cal. BC (Healy et al. 2011). Likewise, little – if any – variation in foodways is seen across the Thames region. Variation relates to the use of pottery rather than to the foods consumed.

## 5.9 Conclusion

Lipid signals from pottery of the fourth millennium BC clearly illustrate that pottery belonged in the domain of keeping, cooking, and consuming food and drink. The assemblages included in this programme of lipid residue analysis are modest. Their size reflects the fact that the pit sites were inhabited by small groups of people. A larger set of samples would allow for more confident conclusions. However, the transformation of data into archaeologically meaningful narratives relies on a series of decisions, regardless of the length of the list of numbers that is ultimately produced. For example, the issue of whether fatty acid ratios are representative of the constituents of original meal ingredients is an interpretive decision regardless of the size of the dataset. Moreover, it is clear that the relevance of lipid residue data depend not only on the state of the pottery assemblage itself, but also on the manners in which it has been treated after excavation. Contamination from handling and storage may be understood and factored in, but the level of attention granted to each assemblage in the published report is also significant. Naturally, there will be variation in how assemblages are treated, just as they were treated differently in the past and have been subject to different circumstances of preservation in the ground. Such variability may be overcome in order to produce coherent output. The bottom line is that the quality of scientific data obtained in this way depends on the character and contextual integrity of the parent assemblage. Not all assemblages are capable of supporting meaningful interpretation of lipid residue data, and this is to do with its state and the quality of recording and archiving as well as with the level of lipid preservation and extraction success. Bearing this in mind, the results presented above can be brought to bear on a series of issues, ranging from the foods consumed to the making of pottery and the nature of occupation at pit sites. These themes are addressed in the next chapter.

# 6. From content to context

*'Science is always wrong. It never solves a problem without creating 10 more.'*

George Bernard Shaw

## 6.1 Introduction

One of the Early Neolithic carinated bowls from Horcott Pit carries a trace of the hands that shaped it. The potter added a coil along the rim and pushed and smoothed the clay of the coil onto the neck of the vessel. This procedure is visible to us as half the coil is now missing, and the sherd is a reminder that beyond all the scientific jargon we spend on these pots it is the human context we are reaching for. Moreover, the makers of these vessels are as significant to consider in this context as the cooks and consumers of food and drink.

In this chapter I collect the details introduced previously and let them underpin a narrative of pottery-use and everyday meals in the fourth millennium BC. I draw not only on the data and discussion of previous chapters, but also on information from previous lipid residue studies undertaken on Neolithic pottery from the Thames Valley. Assemblages from five Early and Middle Neolithic sites in the region have previously been targeted for analysis by GC/MS and, in some cases, by GC/C/IRMS. They include three non-monumental sites: Yarnton Floodplain in Oxfordshire, Eton Rowing Course at Dorney in Buckinghamshire, and Runnymede Bridge in Surrey (Copley et al. 2005). Important domestic remains were recovered at these three sites, and I have mentioned each of them in preceding chapters. Further, two of the previously analysed assemblages come from Early Neolithic monuments: the Ascott-under-Wychwood long barrow (Copley and Evershed 2007) and the Abingdon causewayed enclosure in Oxfordshire (Copley et al. 2005). In addition, pottery from the Windmill Hill causewayed enclosure in the Kennet Valley and, further beyond the Thames catchment, from the Sweet Track in Somerset (Berstan et al. 2008) and the Hambledon Hill causewayed enclosure in Dorset (Copley et al. 2005) has also been analysed. At present, the Neolithic remains at Yarnton Floodplain and Eton Rowing Course at Dorney are not yet fully published. This has implications not only for my review of the information gained but also for the original sherd selection procedures and interpretation of results. The quality of information varies with the extent of contextual and ceramic information available. Significantly, a majority of the existing datasets were produced to explore whether dairy fat could be traced in Neolithic ceramics. It could indeed, and the establishment of an analytical protocol aimed at dairy fat has advanced lipid residue studies on the whole. Here, instead of reiterating the previous datasets, I bring together certain aspects that shed light on issues discussed in previous chapters. Initially, however, I discuss issues to do with sherd selection and limited engagement with cookery, ceramics, and context.

## 6.2 Studying pots

The Windmill Hill causewayed enclosure is located near the River Kennet on the Marlborough Downs, some thirty kilometres south of Horcott Pit and Cotswold Community. Seventy sherds from the Windmill Hill pottery assemblage were selected for residue analysis by Copley et al. (2005a), and half of them were found to contain absorbed lipids (ibid. 528). Just over 40% of those sherds that contained lipids indicated dairy fats. Data from the inner, middle, and outer circuits of the enclosure was compared. The dairy food signal was found to be weaker in sherds from the middle circuit. Lipid signals were not considered against vessel forms in this assemblage, and the way in which sampled sherds were recorded (ibid. 534-6) precludes further analysis. Sampled sherds/vessels were not identified according to the vessel numbers listed in the report on the assemblage by Zienkiewicz and Hamilton (1999). Copley et al. recorded the Ebbsfleet component from most of the site along the Early Neolithic bowls, so it is not clear whether the 'decorated bowls' sampled for analysis are Early or Middle Neolithic. Seven vessels illustrated in Zienkiewicz and Hamilton (1999) can be identified as having been sampled for lipid residue analysis. One of them is a decorated and burnished bowl (P610) that was found to contain traces of dairy. An association between surface treatment and content was seen at South Stoke in Oxfordshire, and such links could potentially have been explored further in assemblages like that from Windmill Hill had more care been taken in sampling and recording for the lipid residue study. Information on aspects such as surface treatment, fabric, volume, and wall-thickness would enhance interpretation of the scientific dataset. Granted, Neolithic pottery is often in a state that inhibits this level of detail. Nonetheless, these circumstances prompt consideration of the ways in which assemblages are sampled for scientific analysis.

Pottery from the Abingdon causewayed enclosure in central Oxfordshire was also sampled by Copley et al. (2005a: 524). They suggest that dairy fat was primarily associated with decorated bowls, while plain bowls tended to contain mixtures of ruminant and non-ruminant meat fat. However, as with the Windmill Hill assemblage, the vessel numbers provided by Copley et al. (ibid. 538ff) do not correspond with those recorded in the original report on the assemblage (Avery 1982: 26ff). Twenty-nine of the reconstructable vessels were sampled for analysis by Copley et al. along with thirty-one undiagnostic sherds. Twenty of the twenty-nine sampled reconstructable vessels are illustrated in Avery's report, but only nine of them match the descriptions listed by Copley et al. For example, vessel 14 is labelled 'plain bowl' by Copley et al. (ibid. 539) although it is a decorated bowl with handles in Avery's report. Vessel numbers are not to be confused with the sample or sherd numbers that are assigned to each sample/sherd by the laboratory. It is generally not practical to adhere to original vessel numbers during the analysis. Nonetheless, it must remain clear which vessel each sample derives from. The Abingdon assemblage is complex. In the report, unstratified pottery from Leeds' original excavations of the monument in the 1920s is recorded along with pottery from trenches opened in 1954 and 1963/4. It is possible that reconstructable components of the assemblage(s) were assigned numbers at different times and that the numbers may have been altered for the published report. The published vessel numbers may or may not have been present in the archive. Regrettably, the Abingdon report does not include a catalogue of illustrated vessels. A minimum of thirteen unstratified vessels from the 1926/7 excavations were included in the lipid residue study. Only three of the thirty-one undiagnostic sherds are listed by Copley et al. as derived from decorated bowls. However, an undecorated sherd may derive from a decorated vessel given that Early Neolithic pottery decoration tends to be restricted to the shoulder and/or rim. Copley et al. (ibid. 530) suggest that adipose fats were mainly processed in undecorated bowls, whereas dairy may have been associated with decorated bowls, but these conclusions should be used with caution, if at all. On the other hand, the indication of dairy fats in one quarter of sampled vessels is valid, if we accept that each sampled sherd represents one vessel.

A similar complication is evident in the organic residue study of the ceramics from the Ascott-under-Wychwood long barrow. Here, the pottery assemblage itself (Barclay and Case 2007) and the organic residue programme (Copley and Evershed 2007) are published in the same volume (Benson and Whittle 2007). Sherds from thirty-one vessels were selected for analysis, of which eleven were found to contain appreciable amounts of absorbed or surface lipids. However, vessel numbers provided in the organic residue report (Copley and Evershed 2007: 285) and the preceding chapter on the assemblage itself (Barclay and Case 2007: 269) do not correlate with one another. Therefore, it is unclear which vessels were in fact sampled for analysis. Nonetheless, it is noteworthy that cooking lipids were obtained in only 35% of sampled vessels. This may be due to the fact that eight cups/small bowls were probably included in the analysis (Barclay and Case 2007: 269). None of them yielded cooking residues, which mirrors the situation seen at the pit sites.

In sum, it appears that large assemblages that comprise material from multiple excavations, collections, and/or collaborators are especially challenging for the researcher sampling for scientific analysis. Familiarity with the characteristics of sampled ceramic styles, along with some understanding of the procedures by which an assemblage is recorded, is useful. Significantly, the objective of Copley et al.'s study was achieved; the use of milk is evident in a significant portion of the analysed pottery. This is an important insight into life in Neolithic Britain. However, it is one that generates many further questions, and those are difficult to pursue on basis of the optional contextual information. Moreover, the chronological framework is vague. Ceramic samples represent a period of two and a half thousand years, yet this is taken as evidence that '[f]rom the onset of farming in Neolithic Britain, dairying was an integral component of agricultural practices, suggesting that it was introduced as a 'package' to Britain from the Continent along with other farming methods' (Copley et al. 2005: 531). The material culture is not of interest, and '[p]otsherds likely to have been used in the 'cooking' of foodstuffs were selected for analysis' (Copley et al. 2005: 524). Cooking is placed in quotation marks, here and elsewhere (e.g. Copley et al. 2002: 10). Perhaps cooking is thought to involve such a bewildering range of unpredictable activities that it is best left aside. However, I argue that many of the terms reviewed in Chapter 1, including 'diet', 'economy', and 'foodways', are poor matches for the kind of information that we obtain from lipid residues. It is cooking and food preparation practices that generate lipid residues. Ingredients matter, but rarely do lipid residue studies reveal use of plant and animal species that were not already part of our archaeological understanding of a site or period. The categories that we use to interpret and communicate lipid residue data – i.e. 'ruminant adipose fat' or 'vegetable foods' do not transform our understanding of what people ate in the past. In addition, we have seen that 'background archaeological information' from plant and animal remains is necessary to establish the most appropriate analytical protocol and to support the results of lipid residue analysis (Evershed 2008a: 912). In other words, scientific data is not the end product. Instead, scientific enquiry provides the raw materials (Firestein 2012). I argued in Chapter 4 that lipid residue data tells us as much, or more, about the use of pottery than it does about food. Ultimately, it relates to the interplay of food and material culture, and it allows us to bridge analytical divides between organic and inorganic components of the archaeological record. In the case of lipid residues from ceramics, it is unwise to separate the pot from its content, as '[t]he properties of the materials used to make pots have a tremendous influence on the outcome of the cooking process and an understanding of them is essential' (Lemme 1989: 82). In the remainder of this chapter, I move away from treating these sherds as laboratory specimen.

## 6.3 Making pots

### *6.3.1 The purpose of pots*

We saw in Chapter 3 that variations in potting skills are evident in Neolithic ceramic assemblages. Isobel Smith (ibid. 94) commented on the 'mud-like' sherds from the Peterborough type-site. On the other hand, the earliest ceramic vessels in Britain have thinner walls and were fired in higher temperatures. However, we need not assume that potting skills gradually deteriorated throughout the Neolithic period until Beaker potters enter the scene towards the Early Bronze Age. Instead, the evidence supports more nuanced trajectories of potting traditions in the fourth millennium BC. The first horizon of pottery in Britain was made by potters active within a deliberately sustained craft tradition. The communities to which the first generations of potters belonged had strong kinship ties across the English Channel or the North Sea. Among them, pottery was an established commodity with known purposes. Potting may have been a revered skill within the new social constellations that emerged as communities with different histories negotiated co-existence and integration. As pottery became known and used across Britain, the know-how of making vessels was dispersed, socially and geographically. After only a few generations, no living memory lingered of a time without ceramics. With varying outcomes, craft traditions fragmented and became more localised. Pottery was not only made by skilled potters. Instead, the skill with which pots were made varied, and an archaeological site from the latter half of the fourth millennium may yield well-made and clunky, under-fired bowls. There are many skilfully made Peterborough Ware vessels – Pot 9 from Horcott Pit is an example (fig 3.8). As pottery became commonplace, its purpose did not necessarily rely on high levels of skill or aesthetics, even though the bowls made by accomplished potters may have been seen as special.

The Early Neolithic ceramic repertoire is conservative in comparison to pottery of later periods. The round-based bowl dominates for almost a thousand years and decoration is modest prior to the emergence of Peterborough Ware. The template for how a pot should look was both widely shared and restrictive. Subtle but significant variation is evident when we zoom in, and this has resulted in the typological predicament discussed in Chapter 3. In my view, the conservatism of Early Neolithic pottery does not reflect a lack of imagination or skill on behalf of the potters. Nor does it reflect simplicity of cookery practices. Instead, it testifies to two circumstances: first, the contexts of manufacture and, second, the sets of organic materials that were used alongside ceramics. We have seen that the earliest known vessels are not products of attempts to imitate or experiment. The bowl had a certain set of purposes, and ceramic technology was not quickly adapted to a range of different uses. We do not find, for example, the plates, strainers, or ceramic ovens of later periods. This is because a wide range of organic containers and tools would have been used to prepare and eat food prior to the introduction of ceramics. The indigenous population maintained their traditions of using containers of leather, bark, wood, leaves, and basketry. Likewise, incoming groups would have made and used pottery alongside other kinds of containers. The implication is that we today only have access to a specific component of the cookery equipment repertoire. Ceramic vessels are not inherently superior. Many organic containers can be waterproofed with animal fat and others withstand heat relatively well. These objects and habits were not swiftly replaced by pottery. Instead, pottery was gradually incorporated into existing repertoires of cookery equipment. Pottery was commonplace in communities with a shared past elsewhere in Europe. Other groups may have been more hesitant. The assemblage from Ascott-under-Wychwood indicates that potting was not a single, controlled event. The processes involved – from digging the clay, sorting, soaking and kneading it, to forming vessels, letting them dry and firing them – may eventually have been casually undertaken alongside other routine tasks. Firing would have required the right weather conditions to last long enough to allow both vessels and wood to dry out. Could the poorly-fired bowls be those that were made during the winter months? Potting activities became routine as communities incorporated pottery into their cookery repertoires.

### *6.3.2 Pots as culinary tools*

Lipid residue analysis suggests that the ceramic component mattered within the set of cookery paraphernalia, most of which does not survive. Cooking residues are generally retrieved in more than 60% of sampled ceramic vessels, including those targeted in this study. The proportion of ceramic vessels used for food is higher when we consider the uses that do not leave fatty residues, such as dry food storage. We have seen that clay was put to few, if any, uses other than pottery-making in this period. Moreover, the clay used on house walls and as ornaments may not have been treated in the same way. Petrographic analysis of daub fragments from the Neolithic site at L'Eree, Guernsey, demonstrated that the clay had not been tempered or kneaded (Sibbesson n.d.). Clay was worked and fired primarily, if not exclusively, to make pottery vessels. In turn, pottery was intimately associated with food. In the Bronze Age the ceramic repertoire expanded to include, for example, crucibles for metal smelting and cremation urns that held human remains. In contrast, food and pottery occupied the same social domain during the fourth millennium BC.

Integration of lipid residue data with ceramic formal attributes sheds light on the ways in which potters accommodated food-processing requirements. For example, the sample from South Stoke hints at a correlation between cooking and surface treatment such as smoothing. Smoothing the ceramic surface reduced permeability and this practice may have been related to the keeping of milk, which is evidenced in the earliest ceramic assemblages. The lipid residue programme on pottery from Eton Rowing Course in Buckinghamshire indicated that beeswax was used to further reduce the permeability of ceramic vessels (Copley et al. 2005). The site, along with comparable remains found under the auspices of the Maidenhead to Windsor and Eton Flood Alleviation Scheme (MWEFAS), contain some of the most significant Neolithic settlement evidence in the Middle Thames region (Allen et al. 2004). Remains include pits, tree-throw holes, flat graves, occupation spreads, and specialised activity areas, and Neolithic pottery of all phases has been recovered (ibid. 84). The earliest phase is represented by Carinated and plain bowls reminiscent of the assemblage from the Staines causewayed enclosure. The beeswax biomarkers detected in ceramic extracts from Eton Rowing Course reflect practices confirmed elsewhere, as substances like beeswax, tallow, and resin-derived products were sometimes used as sealants and adhesives on pottery (Charters et al. 1993 and 1995: 124; Isaksson 2000: 37). Beeswax was identified in lipid residues of Neolithic pottery from Runnymede Bridge in Surrey (Needham and Evans 1987), and indications of dairy-based sealants in British Bronze Age pottery have recently been found (L. Soberl pers. comm.). Not all sealing agents behave in the same way and they would have been applied for different reasons. In the pit site dataset, the possibility that milk or fat was used to reduce permeability of porous vessel walls cannot be ruled out, given the remarkably high quantities of terrestrial animal fat found in several vessels. However, sealing the interior surface of a vessel would prevent our other biomarkers from migrating into the ceramic matrix, and deliberate application of sealants is unlikely since a series of other compound classes are present in this dataset. On the other hand, the makers and users of these vessels would have been well aware of the advantages of gradual accumulation of fat inside a pot during cooking. We have seen that body-sherds yielded very high quantities of absorbed lipids. This is likely to reflect fats accumulating at the base and sides of vessels, not only during cooking but also when the pot was emptied of its content and between uses. Early in the pot’s life, enough fat would have seeped into the porous ceramic, leaving a smooth surface.

The Eton Rowing Course pottery also produced the highest proportion of extracts indicative of dairy fats of all assemblages studied by Copley et al. (ibid. 528). In fact, all compound-specific $\Delta^{13}C$ values of the lipid residues from this site cluster within the reference region for ruminant meat and dairy fat (ibid. 527). There is no indication of porcine foods being processed, and plant foods also seem unlikely. In contrast, $\Delta^{13}C$ values from the other assemblages in the Copley et al. study are more scattered. Interestingly, bowls of the category referred to as ‘indented’ were by far the most likely to contain absorbed lipids, primarily of a dairy origin. The ‘indented’ label is likely to reflect the high number of closed-form bowls from Eton Rowing Course and contemporary sites – it was probably created in anticipation of a full report on the assemblage. Six cups were also sampled from this assemblage. Each of them contained absorbed lipids, in contrast to the cups from pit sites. The lipid signals from three of the Eton Rowing Course cups indicate dairy and one may have contained ruminant meat. It is noteworthy that the ceramics from the Hambledon Hill enclosures in Dorset yielded more frequent lipid residue signals in the open-form bowls (Copley et al. 2005: 530). In contrast, a majority of closed forms did not produce any absorbed lipids at all. However, in the case of Hambledon Hill it is unclear whether the distinction between open and closed forms was made on basis of all sampled vessels, or only on the ones that could not be assigned to any of the other three vessel types (i.e. carinated, decorated, and 'necked'). Unfortunately, the latter appears to be the case as all five types are presented together (ibid.). In other words, we do not know whether a sampled decorated bowl, for instance, was closed or open-form. In addition, the suggested association between Carinated Bowls and dairy fats (ibid. 529) is invalid since no such vessels are represented in the Hambledon Hill assemblage (Healy 2004). However, two sherds of decorated vessels did not yield absorbed lipids – thus reflecting the pattern hinted at in the assemblage from South Stoke.

Some of the changes in ceramic technology that occur during the fourth millennium BC is to do with the ways in which vessels were tailored to meet the requirements of cooking and food preparation. For example, pots with lugs are a recurring component of the plain bowl repertoire. The lugged pots from South Stoke and Benson both yielded high quantities of lipids, indicating that they were indeed intended for cooking. The presence of ketones indicative of repeated heating confirms this. Given this evidence of the purpose of lugs and handles, it is surprising that they are not a more frequent and long-lived feature of Neolithic pottery. Another vessel attribute that may be to do with the accommodation of cookery practices within ceramic repertoires is wall thickness. Thin vessel walls are a defining feature of 'true' Carinated Bowls (Cleal 1992), whereas Peterborough Ware is associated with heavier, thicker forms. This development may be related to the establishment of pottery as a key component of cookery equipment and an emerging preference for using ceramics to cook with heat. These vessels were made by potters who were intimately familiar with cookery practices.

### *6.3.3 The potting process*

Pottery was made to meet immediate needs of the potter's community during the Early and Middle Neolithic. Traded pottery was the exception, but when traded it was likely the content rather than the vessel itself that was the coveted commodity. Since pottery was made with certain functions in mind an account of cookery with pots begins with the ways in which pottery was made. Neolithic potters are likely to have been involved in all stages of potting, from selection and processing of raw materials to drying and firing vessels. Certain tasks may have been 'outsourced' to other members of the community – perhaps children and the elderly took part in, for example, removing impurities from clay. Potting may have been a seasonal activity, perhaps associated with warm summer months. The location of preferred clay sources may have determined where occupation was centred during these months, although preparation of clay may have involved the combination of raw materials from different places. Certain tempering materials, such as flint pebbles and shell, may have been collected throughout the year. Material from a few favoured sources was eventually brought together in pottery vessels that physically represented the entire lived landscape. Selection of the clay itself would have been a compromise; different clays have different properties and few, if any, clays have it all. In selecting clay, the potter would have forfeited certain characteristics in favour of others (Rye 1981: 16). Unwanted accessory particles would then be removed from the clay, probably by drying and crushing it. Tempering material that is to be added to the clay body also requires preparation. The flint, grit, and shell found in much Early and Middle Neolithic pottery is likely to have been crushed with hammerstones. Two such hammerstones, made of flint, were found in the Early Neolithic pits at South Stoke (Cramp and Lamdin-Whymark 2005), one was found at Horcott Pit (Lamdin-Whymark et al. 2009) and one at Cotswold Community (Lamdin-Whymark 2010). Was pottery made at these sites? If not, it seems likely that at least some of the raw materials were processed here. This is also indicated by the burnt, unworked flint that was recovered from the South Stoke pits. The additives would have been blended into wet, plastic clay by kneading, perhaps by foot. The amount of effort put into this aspect of pottery-making would have varied greatly; both well- and poorly-sorted fabrics are known in the Neolithic ceramic record. For example, the Early Neolithic assemblage from Kilverstone in Norfolk contains vessels with veins of tempering material (Knight 2006). That is, the distribution of temper varied even within the walls of single vessels. At South Stoke, all ceramic fabrics were found to be poorly sorted (Edwards et al. 2009). Potters must have been confident that the clay body thus produced would withstand forming, firing, and use regardless of the amount of effort spent on working additives into the clay. The characteristics of the clay body would nonetheless have impacted upon the forming process. For example, the pace of potting is determined by the materiality of clay. In addition to weather, properties such as coarseness of clay and surface texture of a formed pot affect the rate of drying (Rye 1981: 21). Since a vessel can only be formed while there is moisture in the clay, potters would have had to work faster to produce the coarser vessels. British prehistoric pottery tends to be coil-built. This forming technique can be undertaken in stages; for example, the lower part of a vessel may be formed and allowed to dry before the upper part is added, thus providing better support as the upper part is formed (ibid.). As the clay of the formed pot dries, colour and feel changes and an experienced potter will know when the pot is dry. A few significant steps are best carried out at this leather-hard stage. For example, handles and lugs are best added when the clay is dry but unfired. Likewise, many kinds of decoration are applied at the leather-hard stage. If incised decoration is applied during the plastic stage when the clay is still wet, ridges are produced in the clay along the edges of the incisions (ibid. 24). Pottery-making may have influenced the layout of domestic spaces. For example, pots should not be placed in direct sunlight during the initial stages of drying (ibid.). If Neolithic potters took this into account a shaded spot must have been set aside for the purpose of drying pots. The rate of drying dictates the pace of output and other activities associated with potting, including the timing of firing events. Traces of bonfire firings are elusive in the archaeological record, but they must have been a recurring part of life. Firing pottery requires skill; the potter has to control the rate of heating, maximum temperature, and the atmosphere surrounding the pottery vessels (ibid. 25). In an open-air firing, the latter is impossible to control once the firing has begun, so the choice of fuel may have been especially significant to Neolithic potters. Temperature and rate of heating can be governed by the choice fuel. For example, animal dung burns slowly with a gradual rise of temperature, whereas twigs and straw burns quickly (ibid.). If cattle dung was used to fire pottery, this may have further strengthened the association between cows, their milk, and ceramics.

## 6.4 Making food

### *6.4.1 Foods*

The Sweet Track in Somerset has yielded one of the earliest known pottery assemblages in Britain. The Sweet Track is the remains of a wooden trackway, raised across the wetland of the Somerset Levels for nearly two kilometres (Coles and Coles 1986). More recent evidence shows that the Sweet Track was built on top of and parallel to another trackway, built thirty years earlier (Brunning 2000: 72). The site produced a small but important pottery assemblage, comprising both ‘classic’ Carinated Bowls and other vessels (Cleal 2004: 171). The latter are more straight-sided bowls with high shallow necks that are reminiscent of later pottery from causewayed enclosures (ibid.). The assemblage has been subject to a lipid residue study, albeit not due to its earliness but to the robust dating evidence. Dendrochronological dates for the construction of the Sweet Track places it late in the year 3807 BC and into the spring of the following year. The lipid residue programme was designed to explore whether the major fatty acids could be radiocarbon dated (Berstan et al. 2008). Food residues from thirteen vessels indicate that plant foods were routinely processed, and ruminant dairy and/or adipose fat was present in three pots (ibid. 705). The extensive use of plant foods is noteworthy since a similar pattern emerged at South Stoke, which is the earliest assemblage included in this study. This suggests that the first few generations of pottery-users may not have eaten a meat-rich diet, and that this way of eating was maintained by certain groups for some time. The food residue evidence does not rule out other forms of meat consumption since meat need not have been cooked in pots. Nonetheless, it is likely that the consumption of meat was restricted, probably seasonally but perhaps also within communities. Lipid residues do not shed light on whether all members of a group had equal access to the foods cooked in pots, although the near lack of 'individual' ceramic items suggests that food was shared. The same domestic food species were kept in the first few centuries as later on, but animal slaughter may have been a less frequent occurrence in the earlier period. The sites that do have pottery may only represent communities with kinship ties in mainland Europe. That is, the earliest Neolithic sites in Britain are unlikely to represent the entire contemporary population. Mesolithic-style flint scatters are notoriously difficult to date, and some such sites may be contemporary with early ceramic-bearing sites that we label Neolithic. At the latter, everyday meals consisted mainly of dairy and plant foods. Compound-specific $\delta^{13}C$ values from South Stoke, Benson, and Horcott Pit indicate that dairy food continued to be an important source of animal protein, although lipid residues do not shed light on *how* milk was processed and consumed. Routine processing of dairy may turn a vessel 'sour' (Barclay and Case 2007: 275), which may have caused its users to leave it behind. Accidental breakage may not account for all pottery sherds that we recover in middens and pits.

In the latter half of the fourth millennium, more regular consumption of animal source foods such as meat and offal may be associated with the development of thick-walled ceramics. Dishes that were not cooked on an open flame but included bone would have required long cooking times. Faunal assemblages from Runnymede Bridge in Surrey (Serjeantson 2006) and Horcott Pit indicate that pieces were small enough to fit in a pot. I suggested in the previous chapter that bone may have been thrown on the fire during or before the meal, given that much of it had been calcined. The assemblage from Runnymede contains heavy-rimmed plain bowls and an unusually high proportion of decorated bowls (Longworth and Varndell 1996: 100). Peterborough Ware of the Ebbsfleet style is also represented (ibid.). Again, just over 60% of sampled vessels contained appreciable concentrations of absorbed lipids (Copley et al. 2005: 528), and a significant portion of them suggested dairy food processing. We have seen, however, that an unusually high proportion of the Runnymede faunal remains are pig bone (Serjeantson 2006). Pork may have been an important food for its inhabitants, but the strong tradition of preparing dairy foods in ceramic vessels also persisted. The two lines of evidence are not contradictory.

Lipid residue data from Yarnton Floodplain in Oxfordshire also sheds some light on the consumption of pork and ruminant meat. The prehistoric ceramic sequence from Yarnton Floodplain includes Early Neolithic through to late Bronze Age/early Iron Age pottery (Hey and Bell 2000: 25). Middle and Late Neolithic assemblages are the most substantial – more than eight kilos of Peterborough Ware and almost six kilos of Grooved Ware were recovered (ibid.). In contrast, the Early Neolithic component was modest, comprising only 61 sherds. Sampling for lipid residue analysis therefore targeted the Peterborough Ware, Grooved Ware, and Beaker components of the Yarnton pottery (Copley et al. 2002, 2005a). Ninety-one sherds were selected, including twenty-one Peterborough Ware bowls. Lipid residues indicated that dairy, ruminant adipose, and porcine adipose foods had been cooked, but as the assemblage is not yet fully recorded this information cannot be linked back to specific vessels. Notably, however, the associations indicated elsewhere (e.g. Dudd et al. 1999; Mukherjee et al. 2008) of Peterborough Ware with cattle and Grooved Ware with pig are *not* supported in the Yarnton dataset (Copley et al. 2005: 529). Pig fat on its own was only detected in one Grooved Ware sherd. Copley et al. (2002: 15) also suggest that vessels that contained dairy and/or ruminant adipose foods are less likely to produce evidence of food mixing. That is, milk and meat from cattle or sheep/goat were strongly associated with specific vessels, and these foods were not mixed to the same extent. Moreover, Copley et al. (2005a: 252) point out that fewer sherds from Yarnton contained absorbed lipids compared with those of the other sites. However, this is accurate only if the Beaker component, of which only two of thirty-six sherds contained absorbed lipids, is included. Beaker vessels are not bowls and they often have thinner walls than earlier pots. Their inclusion in grave assemblages suggests that they were for individual use. Beakers aside, nearly half of the Peterborough Ware bowls and more than 60% of Grooved Ware vessels were found to contain appreciable concentrations of lipids. These figures compare well with those of contemporary assemblages. Cooking fat residues from Yarnton thus reiterates that ceramics and food were closely entwined by the late fourth and into the third millennium BC.

### *6.4.2 Pot cookery*

A newly fired vessel may require further treatment before it can be used for cooking. For example, coating can be applied to reduce the permeability of unglazed vessels. We have seen that milk fats would produce an airtight and smooth surface. Coats or sealants applied to exterior surfaces would burn off during use, however. Sealing a vessel to make it more suited to its intended use is perhaps more likely to be done by the cook rather than the potter, although this may well have been the same person in the Neolithic. The sealant must not only interact in the desired way with the ceramic, but also with the vessel content; it must not impact negatively on the taste of foods and it must behave in a useful way during cooking. For cooking fires, thin branches that burn fast and hot may have been used to cook certain foods but would have been unsuitable for others. Logs would have been used for slower, less intense fires. Given the presence of burnt animal bone at Horcott Pit, it is worth considering the use of bone as fuel. Like wood, bone needs to be dried before it can be used as fuel (Vaneeckhout et al. 2010: 9). Were pottery and bone sometimes dried together during the warmer months? Experiments of burning elk and bear bone indicate that the addition of bone to a fire makes it burn brighter and at lower temperatures than wood-only fires. However, bone cannot replace wood as fuel, as a high proportion (>25%) of bone to wood results in unstable and uneven fires (ibid. 10). The pieces of bone thrown on the fire at Horcott Pit would have burned relatively fast since they were chopped up for cooking and marrow extraction.

The round-based forms of Early and Middle Neolithic vessels would withstand repeated heating better than the later flat-based vessels of the Late Neolithic onwards. Round-based vessels are less prone to cracking during cooking, but they need to be balanced. However, without level surfaces this need to balance a pot is less critical. It is likely that the later development of flat-based pottery went hand in hand with a new preference for level surfaces – perhaps both on a hearth and elsewhere. Carinations and shoulders on round-based vessels would have helped keep contents from spilling as pots lay on the ground, inevitably at an angle, although round-based pots can be placed on a doughnut-shaped contraption to stay level. Carinations and shoulders may also have been used for suspending pots above the hearth. Whether cooking pots were placed immediately on glowing embers, heated rocks, or suspended above the hearth is left to our imagination. Deep, straight-sided vessels are the most intriguing in this respect as they must have been balanced and/or suspended in some manner, but this would have been more challenging than with the shallower, carinated pots.

Given the persistent presence of milk fats in pottery sherds it is likely that ceramic vessels held dairy foods, and storing of milk is perhaps an overly simplistic interpretation. I suggest that milk was not, for the most part, consumed fresh but was instead processed in a variety of ways. Milk is a versatile commodity. Residue analysis has indicated that the pierced 'cheese-strainer' ceramic vessels of Neolithic Poland were indeed used to process dairy foods (Salque et al. 2013). No such vessels are known in the British Neolithic, but milk-products can also be strained using reeds and other organic materials. Equally, pots need not have been placed on a hearth in order to heat-process food. Experimental work by Wood (2000: 92) indicates that cooking stones placed inside ceramic vessels can be used to produce, for example, soft cheese. Heated pebbles dropped in a mixture of milk and sour cream causes it to steam and boil, thus separating curd from whey. The study by Wood was designed to mimic Bronze Age remains found in Cornwall. However, such 'pot boilers' are pebble-sized and may be present but difficult to detect in the Neolithic record, unless they were conspicuously placed and/or deliberately searched for by the archaeologist. It is possible that certain types of stone absorbed milk fats that are detectable by residue analysis. The curd produced by this technique can be dried and processed for storage. Great diversity is evident in parts of the world where traditional dairy-processing techniques are still undertaken. For example, foods made of drained and dried sour milk are known as *kashk* in Central Asia and the Near East. The precise ways in which *kashk* is produced and used varies, often regionally rather than nationally. In parts of Turkey, such loaves of dried sour milk or yoghurt were in the medieval period mixed with cracked wheat to produce *kishk*, a durable and nourishing food that was eaten during winter (Lewicka 2011: 230). For consumption, the product had to be soaked in hot water to be used as 'an ingredient in a variety of one-pot meat preparations' (ibid. 229). Were Neolithic pots used to soak *kishk*-like foods during the cold months? Whey is less versatile but is unlikely to have gone to waste; a variety of cheeses made from boiled whey are traditional in the Balkans and parts of Eastern Europe. Whey and curd may not have been completely separated. Cottage cheese, for example, is a mixtute of whey and curd pieces. Which of these procedures were known and practiced by inhabitants of Britain in the fourth millennium BC? The know-how of turning milk into safely storable foods must have been valuable in the earlier part of the period. The *kashk*-type dry loaves must have astounded indigenous groups, even if domestic cattle and milk were not unfamiliar.

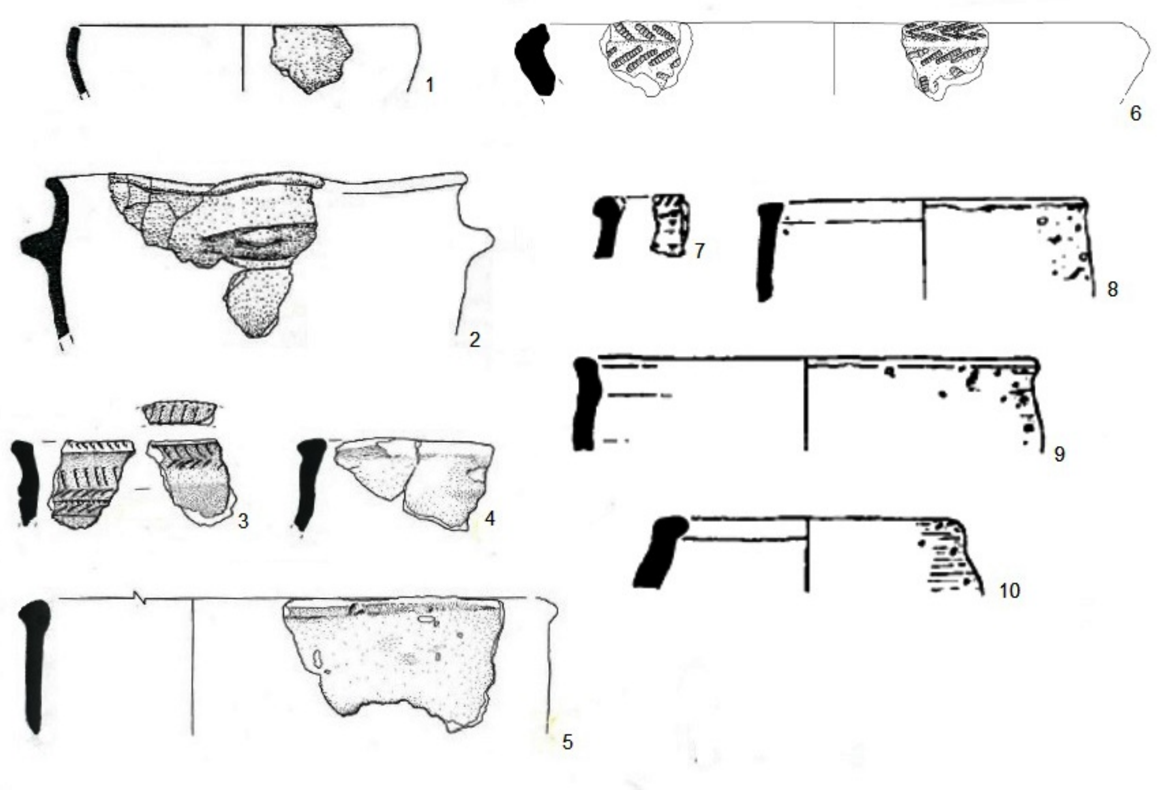


**Figure 6.1** Vessels that yielded traces of dairy fats (1,2 South Stoke; 3 to 5 Horcott Pit; 6 Cotswold Community; 7 to 10 St Helen's Avenue, Benson)

Another material that may have been used to cook is unworked riverine clay (Wood 2000: 96). Clay-baking of foods such as fish may be a post-Neolithic phenomenon, as findings of burnt clay at Bronze Age sites in Stannon and Trethellan in Cornwall may be associated with cooking (ibid. 95ff). Burnt clay was recovered from the postholes of the Early Neolithic house at Yarnton (Hey and Robinson 2011b: 234). However, the interpretation of baked clay fragments as food-related is tenuous; such material is commonly interpreted as daub. Again, residue analysis of the fragments may shed light on whether they were used for cooking or as building material. Nonetheless, we have seen that boiling food with plenty of water is an unlikely scenario. Boiling food in water is a costly method in terms of fuel, and it places specific demands on the cooking pot. The pot must be able to withstand prolonged heating and it must not absorb or leak too much of the liquid. Flavoursome and nutritious fat and meat-juices would be lost if meat were boiled and the water discarded (Wood 2000: 92). Wilson (2013) points out that since water and fire are natural enemies, their combination in food preparation is counterintuitive and may be a relatively late development. As new social and culinary constellations emerged in the Early Neolithic, a quick shift to such a laborious method as boiling is unlikely. Instead, gruel-type dishes that contain grain and other vegetables that absorb meat fat are more compatible with the biochemical evidence. Other heat-reliant techniques would have included roasting, smoking, braising, and frying. Roasting is the most immediate form of cooking as it involves direct contact between foodstuffs and naked flames. Any other form of cooking with heat requires a medium that separates the food from the heat source (ibid.). Nature provides some such intermediate materials in the form of shells, and it is likely that such foods were central in Mesolithic cookery practices. Foods that are pre-packaged by nature – eggs, shellfish, nuts – can be cooked without much modification or additional containers. We have also seen that food processing prior to and alongside pottery would have involved a wide range of organic materials that do not survive. They would have included the use of animal stomachs, although in that case the container itself can be eaten. Cooking with heat may have been only one aspect of food preparation. It is difficult to gauge from the archaeological record, but the use of techniques such as fermentation and soaking of foodstuffs should not be underestimated. Pottery may have been used to soak and cook food items like the dried dairy loaves discussed above. Pots that broke during cooking meant not only loss of the pot but also the food within it. Were pots with cracks decommissioned as cooking pots to instead be used for storage? Once broken, sherds were left in the hearth or among heaps of waste, some of which ended up in pits. In the late fourth millennium, large sherds from certain vessels may have retained some of the significance of the intact pot. At Horcott Pit, one such sherd was placed against the side of the pit with the decorated surface facing outward (Lamdin-Whymark et al. 2009: 120). That is where it sat until it was excavated twelve years ago.

### *6.4.3 Pit cookery*

The immediate context of the pots studied in this project is the pits from which they were recovered. I mentioned in Chapter 2 that pits may not have been dug primarily to hold the material debris that was left behind. That is not to say that acts of deposition were insignificant, but it does prompt us to consider the ways in which pits were used during occupation of a site. In my view, pits were not necessarily dug as part of a closing and leaving the site. The lack of evidence for silting or weathering of the sides of pits may instead be to do with the brevity of occupation. We have also seen that the presence of middens at many pit sites suggests that not all cultural material had to be sealed in the ground upon leaving the site. I suggest that one purpose of pits prior to deposition was to do with food preparation and/or storage. This line of enquiry has been pursued for prehistoric pit features in North America (Wandsnider 1997; Dunham 2000), Sweden (Eliasson and Kishonti 2007; Lindfors et al. 2008), and Britain (Loveday 2012). As we saw in Chapter 2, Loveday (ibid. 102, 105) suggests that baked earth, fire-induced colour changes, and lumps of fired clay at two pit sites in Derbyshire are indicative of pit roasting and/or cooking. He points out that the pits may be the subterranean remains of more complex features. He also argues that the absence of evidence for in-situ-burning at many other sites may be to do with the low temperatures involved in pit cookery (ibid. 108). The slow, non-intensive fire required for drying (c.50°C) and roasting (55°C to 95°C) may not result in archaeologically visible changes in soil colour (ibid.; Wandsnider 1997). Such temperatures can be achieved through hot-rock cookery. We have seen that burnt stones were recovered from two Middle Neolithic pits at Cotswold Community (Powell 2010b: 82). What is more, several papers in the recent volume on Neolithic pits in Britain and Ireland, edited by Anderson-Whymark and Thomas (2012), contain numerous mentions of fire-cracked stones and/or burnt pebbles found within pits. These mentions are generally made in passing, although the heated stones are sometimes highlighted as evidence for food processing. For example, Brophy and Noble (2012: 69, 73) mention that the pits at Carzield Kirkton in Dumfries and Galloway have been interpreted as fire pits or cooking pits due to the presence of burnt pebbles. Also in Scotland, pits at the Carrick on Loch Lomond contained fire-cracked stone and in-situ charcoal, and a fire-cracked stone was found along with pottery in a pit at Maybole in Ayrshire (Becket & McGregor 2012: 59, 56). Thomas (2012: 7) draws attention to the Hatton Farm pit site in Angus, where one pit contained a large number of Carinated Bowl sherds and ‘a mass of burnt sandstone cobbles’. Thomas considers this to be a ‘special’ site (ibid.). Further south, burnt stone was recovered from pits at Wellington-Moreton in the Severn-Wye region (Jackson and Ray 2012: 149). The pits at Horton in Berkshire contained burnt stone – albeit flint – and fired clay along with plain bowl sherds and other debris (Chaffey and Brook 2012: 207). In

Ireland, burnt stone has been found in pits at sites such as the Cohaw tomb in Co. Cavan and at Kerlogue in Co. Wexford (Smyth 2012: 17). Hearth-pits are also known in the Irish Neolithic (ibid. 24). Pit cookery practices would have varied regionally. For example, there is no evidence of in-situ burning in pits in Western Wales (Pannett 2012: 130). In addition, pits need not have been dug and used exclusively or even primarily for food processing and storage purposes. The burnt stone recovered from many British pit sites may have originated from hearths rather than having been used in the pits themselves.



**Figure 6.2** Techniques of hot-rock cookery in pits from known North American examples. From Thoms 2008

Nonetheless, the association of pits with food processing may have fallen out of the archaeological consciousness in Britain more than elsewhere. Pits in the Swedish prehistoric record are known archaeologically not as *gropar* (pits) but *kokgropar* (cooking pits). This terminology may restrict interpretation, but it also means that prehistoric pit cookery is better engaged with and understood. For example, Eliasson and Kishonti (2007: 124) suggest that the pits found during construction of the Öresund Bridge in southern Sweden 'were used for food preparation as heated stone and food, perhaps wrapped in leafs, were placed in a pit. The pit was covered and the hot-rocks generated an even and lasting heat' (own translation) (fig. 6.1). The pits' association with cookery does not preclude a ritual aspect; it is acknowledged that the *kokgropar* may have had several other purposes in addition to food preparation (Thörn 1993; Lindfors et al. 2008: 133). At the same time, the term 'cooking pit' may also be too wide. Ethnographic information demonstrates that further insight could be gained from understanding and distinguishing between earth ovens, steaming pits, and boiling pits (Thoms 2008). Hearth-pits are rare but present in the British record. For example, charcoal-rich basal layers were observed in pits at the St Osyth causewayed enclosure in Essex (Loveday 2012: 108; Germany 2007: 25-32). At Willington in Derbyshire, fire-cracked pebbles were found in a Mortlake ware pit that had a charcoal-rich base layer sealed by clay (Loveday 2012: 104). Some of the pits at the substantial pit site of Meadowend Farm in Clackmannanshire were interpreted as hearths due to the presence of heated sandstone slabs (Brophy and Noble 2012: 71; Jones 2006). Thus hearth-pits are known but probably less frequent than pits containing burnt stone. Lindfors et al. (2008: 133) point out that a hearth placed on flat ground or in a shallow depression would have generated more heat and light to those sitting around it than a fire lit in a pit would have done. One way of addressing whether pits were used in food processing would be to analyse soil samples for lipid residues. This approach was tested on remains excavated during the Öresund Bridge construction, when a number of Neolithic and Bronze Age pit sites were found.  Fatty acid profiles of soil samples from pits, hearths, and hearth-pits were analysed by GC/MS (Eliasson and Kishonti 2007: 135). Soil samples from the pit fills and from the earth surrounding the pits were taken. Fatty acid quantities were in some cases found to be higher in the pit fill samples, although this may be a result of naturally degraded plant matter. On the whole, results were inconclusive due to the difficulty in interpreting the origin of detected residues.

In my view, we neglect evidence for pit cookery in the British Neolithic at the expense of better understanding of everyday lives. The fact that pits are most commonly encountered during developer-funded excavations with limited scope for detailed study and that their documentation is generally confined to the grey literature (Brophy and Noble 2012: 63) may constrain more comprehensive identification and synthesis of evidence such as fire-cracked rocks. The Swedish term *skärvsten* can refer to all stone affected by fire, but more specifically it is fire-cracked stone with sharp edges. In contrast, stone that is *skörbränd* is crumbly and easily crushed (Lindfors et al. 2008: 131). The difference is to do with the original composition of the stone rather than the way it was used (ibid.). Some hot-rocks may have been used until they were almost pulverised (ibid. 155), which would have implications for their frequency in the archaeological record. Wandsnider's (1997) review of cookery techniques in the ethnographic literature suggests that fatty meats tended to be roasted whereas leaner meats were more likely to be boiled. Pit roasting was recorded as a widely preferred method of cooking the fattiest meats and organs (ibid. 12). Exposure to heat denatures protein, which renders it more chewable and digestible (ibid. 9). Protein is rapidly denatured when the fat content is high since the fat enables the heat to permeate the meat tissue. Wandsnider (ibid. 14) argues that '[i]t is not surprising, then, that large aggregations of people and roasts of fatty meats are often associated'. This echoes our understanding of the goings-on at the large Neolithic monuments (e.g. Evans 1988; Whittle et al. 1999; Oswald et al. 2001). Boiling/soaking of dried meats was also frequently recorded (Wandsnider 1997: 12), and this may be compatible with the evidence from pit sites. Another ethnographically well-attested practice is to store food in pits. Placing food in pits for later recovery may or may not be intended to alter the food through fermentation. In the US, ethnographic sources describe food being 'stored in woven sacks, animal skins, baskets, bark containers, ceramic or metal vessels, or glass jars' within pits that had been lined with bark, grasses, or hay (Dunham 2000: 230). The storage pits of Dunham's study are of similar depth to many Neolithic pits (c. 50-90 cm) but their diameter tends to be larger (c. 100 cm). If pits were lined with bark or basketry we might expect to detect the impressions of such materials, at least in rare circumstances. However, storage of dry foods in pits is even more difficult to identify archaeologically than heat processing of food. Nonetheless, Thomas (1999) may have thrown the baby out with the bathwater when he rejected the idea that Neolithic pits were not used for storage because they are different from Iron Age pits. The Iron Age pits were designed for grain storage, but grain storage pits are complex in that the upper and other layers of grain begins to germinate in contact with the moisture of the surrounding earth. This process uses up all oxygen in the pit, and as the germinating layer dies it becomes a crust that seales the grain on the interior (Wood 2000: 99). Once the pit is opened and the sealing layer is broken, all of the grain inside it has to be used immediately. However, grain was not a large component of Neolithic diets, and a wide range of other foods may be stored in pits: 'we opened [the pit] and it had all kinds of nice foods that we had stored in the fall. There were cedar-bark bags of rice and there were cranberries sewed in birch-bark makuks and long strings of dried potatoes and apples' (Densmore 1979 in Dunham 2000: 243). Food may be stored in pits for a number of reasons: to set aside seasonally abundant foods, to conceal it, or to provide meals for community members involved in transhumant journeys.

In sum, the circumstances of accumulation of the debris that ended up in the pits may have been unrelated to the act of deposition (Anderson-Whymark's 2012: 188). However, this does not explain the pit itself. The fact that some midden material was left on the surface indicates that the pits were not dug primarily to hold the debris of occupation. That one of the purposes of pits was to do with food preparation and/or storage helps explain their ubiquity in most regions of Britain over thousands of years. The growing concern with formality of deposition that emerges over the fourth millennium BC and the use of pits prior to deposition are not mutually exclusive.

## 6.5 Towards new narratives

### *6.5.1 Life at a pit site*

Pit cookery can take hours and the smells of the foods within the pits may have been a persistent part of life at these sites. However, the preparation of food for storage and consumption would have taken place alongside a range of other activities. For example, plant processing is evidenced in the flint assemblage from South Stoke (Cramp and Lamdin-Whymark 2005). This may not be food-related; rope or textile may have been made here. Flint tools were used for scraping, cutting, boring, and carving (ibid.). The flint assemblages also yielded clues about links with other places. The Horcott Pit and Cotswold Community assemblages comprise flint collected at different locales in the landscape, including river gravels and chalk regions. The flint assemblage from Horcott Pit contained a raw material that had been brought in from the Middle Thames Valley. At least three flint sources are represented in the Cotswold Community assemblage, but it is clear that contemporary groups elsewhere used different sources of flint (Lamdin-Whymark 2010). Cotswold Community is a Middle Neolithic site, and it is typical for the period in that the flint assemblage contains finished, and often broken, tools. Most of these tools had been made elsewhere; flint knapping was not one of the routine activities undertaken here.

Similarly, the Middle Neolithic flint assemblage from Horcott Pit contained less knapping debris. In contrast, in the Early Neolithic flint tools were made at these kinds of sites. This conforms to a regional pattern of more substantial Early Neolithic flint assemblages and more restricted sets of tools associated with Peterborough Ware (Lamdin-Whymark 2009: 101).

Thus the character of occupation at these sites shifted somewhat during the fourth millennium BC. In addition to the flint evidence, clearings in the forest would have been better maintained and perhaps larger in the Early Neolithic. The Early Neolithic pits at South Stoke contained evidence of timber debris from recent clearings accumulating on the ground (Stafford 2005). The molluscan assemblage from Horcott Pit contained more shade-loving species in samples from Middle Neolithic pits than in the earlier features (Stafford 2009). At Cotswold Community, charcoal evidence suggests a fairly open landscape but the molluscan assemblage contained only shade-loving species (Challinor 2010; Champness and Stafford 2010). This may reflect that firewood from preferred species such as hazel were collected in the wider area and brought to the site. The wider landscape comprised both open and forested parts, and the site itself was near or in the forest. The differences in character between Early and Middle Neolithic occupation probably reflect gradual transformations rather than a ‘transition’. The stronger concern with creation and maintenance of open areas in the Early Neolithic may be related to cereal cultivation. Comparing the four sites, the largest collection of cereal grains (wheat) was recovered from South Stoke (Huckerby and Druce 2005). One grain of hulled barley was found at Benson but it could have come from a wild variety (Robinson 2004). Notably, lipid residues from the South Stoke pottery assemblage also yielded a stronger plant food-signal than residues from the other three assemblages. This may be to do with processing of cereals in ceramic vessels. In this respect, the evidence from these four sites conforms to the idea that cereal cultivation subsided a few centuries into the fourth millennium BC (i.e. Stevens and Fuller 2012). The early pottery assemblage from the Sweet Track also yielded strong evidence of plant foods (Berstan et al. 2008). Cereals aside, the use plant foods did not shift markedly throughout the fourth millennium. Hazelnuts dominate all four plant assemblages. No variation in plant food use was detected between the Early and Middle Neolithic pits at Horcott Pit (Challinor 2009).

Life at these sites involved the making of clothing, pottery, and flint tools, in addition to cooking and keeping warm. These activities generated waste that was left on the ground and/or in pits. The relatively fresh condition of flint at South Stoke suggests that this accumulation – and, therefore, the activities that gave rise to them – did not continue for long periods of time (Cramp and Lamdin-Whymark 2005). At Horcott Pit, the pottery and bone was found in a poor state of preservation and display some signs of being worn through surface accumulation (Lamdin-Whymark et al. 2009). As at South Stoke, however, the flint debitage is pristine. This led the excavators of Horcott Pit to suggest that occupation lasted long enough for pottery and bone to become worn, but too briefly for the flint to display signs of wear and burning. Significantly, however, the wear on pottery and animal bone is also to do with the ways in which they were used. The midden accumulations at Horcott Pit would also have been modest (ibid.). Therefore, relatively short episodes of occupation seem likely, perhaps lasting a few weeks.

### *6.5.2 The bigger picture*

Pottery and food were closely linked in the Neolithic period. What is more, food residue evidence now supports a strong association between pottery and dairy food in particular. Previous food residue studies on Early and Middle Neolithic pottery certainly point in this direction. The new evidence presented in Chapter 5 indicates that lipids sometimes degrade in ways that obscure a dairy food signal to instead suggest porcine foods. In other words, even if we reject the idea of a Neolithic package, some of the traditional components thereof may have depended on one another. Milk and pottery were connected, and the persistence of one in the archaeological record may be related to the use of the other. However, this does not add weight to either of the two dominant scenarios of the fourth millennium BC that I described in Chapter 1. Neither a gradual incorporation of new foods nor a wholesale and traumatic shift to agriculture can be sustained. Foods from new plants and animals did not gradually replace more familiar species as time went on. The food species that we find on archaeological sites remain the same throughout the fourth millennium BC. However, ways of managing, eating, and thinking about different animals and plants almost certainly shifted during this period, although no real distinction between Early and Middle Neolithic cookery can be discerned in the food residue data from the Thames Valley and beyond. Early Neolithic bowls and Peterborough Ware seem to have been used in much the same ways. At the same time, the latter half of the fourth millennium may have seen increased mobility and social fragmentation, as indicated by the more numerous but scattered and isolated pit features (Hey and Barclay 2007; Lamdin-

Whymark 2008: 189). Cattle and maybe sheep/goat husbandry is thought to dominate lifestyles by the close of the fourth millennium BC. However, the increased visibility of cattle husbandry in the archaeological record need not mean that subsistence strategies radically changed towards the Middle Neolithic. The question of whether the significance of cattle increased during the period is poorly formulated. Cows were never insignificant in the communities with kinship ties across the sea. Recalling Driver's (1983) framework for assessing the fate of an immigrant cuisine, cattle would have been a particularly resilient component thereof. The Early Neolithic is, among other things, a story of intercultural food hybridization since neither the indigenous hunter-gatherer nor the immigrant agricultural food cultures remained intact. The immigrant food culture contained new foodstuffs and new technologies. Driver's food culture characteristics include differentiation, evolvability, imitability, accessibility, and vulnerability. Certain elements may have been particularly vulnerable to the new social and environmental conditions of the British Isles. Cereals, for example, became a minor component of the plant food repertoire after only a few generations (Stevens and Fuller 2012). Food residue evidence of meals that are likely to have contained grain is strongest in the early assemblages from the Sweet Track (Berstan et al. 2008) and South Stoke. It is beyond the scope of this project to explore the contexts in which the new food culture characteristics were exposed and accessible to the 'host' population. My emphasis has been on the ceramics – a technological element of the new cookery repertoire that proved remarkably imitable and evolvable. The 'typological' patterns and variations that we see in the ceramic record reflect this.

Pottery was a key component in the transformation of raw ingredients into food. Ways of preparing food varied between different groups, and this is seen most clearly in the GC/C/IRMS dataset. The groups that ate together were relatively small at pit sites, perhaps especially in the Middle Neolithic. The size of vessels does not change during the fourth millennium BC; a Peterborough Ware bowl would not hold more food than a plain bowl from the first half of the millennium (Cleal 1992). Instead, vessels of different sizes were used alongside one another. Despite this small-scale variation, there is a consistency in foodways in this period. We have seen that a food culture involves 'the shared values and symbolic meanings that inform food choices' (Albala 2011: x), and it is clear that such values and meanings were shared across the study region and throughout much of the fourth millennium. Milk and other dairy foods were staples that provided animal protein throughout the year. Milk from sheep/goat may have been used differently from that of cows, but at present our analytical techniques cannot distinguish between them. Carcass animal foods may not have been staples in the same sense. They were not eaten in everyday settings, at least not fresh. A living animal is a form of food storage, especially if food can be obtained from it while it is still alive. Slaughter was a special event that only occurred at certain places, at certain times, with certain people. A place like the Abingdon causewayed enclosure may have been associated with flavours that were not available during the rest of the year. Nonetheless, meat and offal foods from cows, pigs, and sheep/goat were staples in the sense that they upheld the social order. Their consumption in inter-group settings reinforced shared ideas about the edible and the palatable. The animal bones and meat fat residues we find at pit sites are carefully kept leftovers of the feast. Pits may have been used to prepare carcass foods for storage. Moreover, dried or smoked meat may have been boiled. We have also seen that bone was boiled for marrow extraction. These meals were at times complemented by hunting; bones of roe deer and red deer were recovered from Middle Neolithic pits at Horcott Pit (Evans 2009). For the most part of the fourth millennium, cultivated cereals were minor or absent among plant foods. Instead, hazelnuts, crab apple, and blackberries were eaten regularly. These and other such species may have been managed to some extent, and we have seen that hazel provided hearth fuel as well as food. Ultimately, the issue of whether 'domestic' or 'wild' food species were staples is probably misleading. It is unlikely that the inhabitants of Early and Middle Neolithic Britain considered themselves to be eating a combination of wild and domestic foods. It is absurd to continue the dispute over the relative input to overall diet of food-categories that would have been meaningless to the consumers themselves.

## 6.6 Conclusion

In this project I have shifted focus away from the colonisation versus indigenous-adoption dichotomy, to instead focus on interaction. For example, the spread of pottery across Britain and the later changes in pottery styles are to do with interaction. Not only between groups of people, but also between foodstuffs, material culture, and food culture. I have discussed the ways in which archaeologists interact with scientific datasets, and how scientists interact (or fail to do so) with archaeological datasets. To interpret the accommodation and evolution of new food culture elements such as cattle and pottery as a swift replacement of indigenous lifestyles is simplistic, and it harks back to interpretive models that were articulated more than a century ago. Instead, the persistence of cattle husbandry and the abandonment of cereal cultivation are testament to the hybridisation of different lifestyles and food cultures. I have argued that traditional approaches to food evidence are not the most constructive way of understanding such food cultures. They can be addressed through study of lipid residues from ceramics, and I have done so by abandoning blanket-terms such as ‘diet’ to instead look at Neolithic cookery practices from the bottom-up. This approach has generated intimate accounts of the ways in which ingredients from certain plants and animals were transformed into food. These are activities that helped create and reproduce the ways of life that we know as Neolithic.

# Conclusion

## Project summary

This project is to do with the kind of data generated by food residue analysis of prehistoric ceramics. The context of this enquiry is the economically ambiguous Early and Middle Neolithic in Britain. This ambiguity stems from the fact that the idea of a Neolithic package is obsolete. Archaeological research in the latter half of the twentieth century helped to disperse the appearance and early use of the components of the Neolithic package across vast distances and, especially, over long periods of time. For example, we now acknowledge that pottery and sedentary lifestyles may be *independent* features of the prehistoric record (e.g. Jordan and Zvelebil 2010). In Chapter 1, I argued that some such features have been liberated from the Neolithic package at the expense of others. Namely, our notion of the Neolithic is still tied tightly to evidence for agriculture in the archaeological record. The reasons for this persistent association between farming and the Neolithic are exposed when we trace the concept of the Neolithic back to the nineteenth and early twentieth centuries AD. However, we also saw that Gordon Childe and the other architects of the Neolithic anticipated more complexity and nuance to emerge as archaeologists improved their techniques and datasets. Today, we are struggling with the nuance that is indeed emerging thanks to refined chronologies and an expanded battery of scientific techniques. Ironically, the recent trend is that the more 'scientific' approaches underpin the most conservative and rigid interpretive frameworks. To redress this, I suggested that we need to go beyond blanket terms such as 'diet' and 'subsistence'. Neither the interpretation of scientific datasets nor our understanding of Neolithic foodways is advanced through the use of such vague and top-down terminology.

I have focused instead on the activities, choices, and habits that make up what we refer to as 'diet'. This is a worthwhile approach to the British Neolithic for two reasons: first, it enables us to transcend the a priori association between farming and the Neolithic to instead look at the evidence on its own terms. Second, the origins and character of the British Neolithic is the subject of long-standing debate among prehistorians. The issue of whether immigrant or indigenous groups were responsible for the changes we see in the archaeological record from around 4000 BC is unresolved. In my view, neither of the two dominant scenarios is wholly appropriate. The record reflects complex combinations thereof. To address these, I have approached food evidence of the Early and Middle Neolithic through smaller scale concepts such as cookery and food culture. Specifically, food residues in pottery assemblages from four pit sites in the Upper Thames Valley were characterised by GC/MS and GC/C/IRMS. Pit sites were selected because they contain important evidence of life beyond the conspicuous monuments of the Neolithic. Moreover, pits represent temporally well-defined episodes and we can be certain that the content of each pit or cluster of pits was used together. The Thames Valley is one region in which several pit sites have come to light during developer-funded excavation in the last couple of decades. Many other sites with evidence of non-monumental 'domestic' occupation have also been discovered here, and a picture of everyday lives is emerging.  The food residues of pottery from pit sites yielded further insights. For example, it revealed that animal source foods were on the menu throughout the period, but probably in varying proportions and manners of consumption. Plant foods are more elusive in the food residue record, but they are certainly present in this dataset. There is some indication that the hazelnuts commonly found on Neolithic sites were included in the dishes cooked in pots. Riverine and marine foods, on the other hand, had not left traces in the ceramics. If consumed at all, such foods were not cooked in pottery vessels.

Significantly, food residues from ceramics do not only relate to the ways in which people cooked and ate food. Food residues also reveal patterns of pottery use. The implication thereof is that food residues are relevant to our study of material culture as well as foodways. This is especially relevant for Neolithic pottery since, as we saw in Chapter 3, conventional typological approaches have not been entirely helpful for the ceramic record of this period. Early Neolithic bowls have been stylistically arranged and rearranged several times, but most of the labels thus devised have been abandoned. Peterborough Ware pottery of the Middle Neolithic has seen the opposite treatment; the tripartite scheme put forward in the mid-twentieth century remains intact and little critical evaluation of the labels have been attempted. Traditional pottery analysis centres on the ways in which the vessels were made. It details the fabrics, decorative techniques, and forms of vessels. My study of food residues from pottery suggested that it may be unwise to analytically separate manufacture from use and discard in the study of Neolithic ceramics. Biochemical reconstruction of pottery content is a relatively recent possibility, and it has been scientifically – not archaeologically – driven. This is the reason why closer integration of traditional and current scientific approaches to prehistoric pottery is overdue. However, Neolithic pottery rarely survives intact. It is often fragmentary due to circumstances of manufacture, use, and deposition. Vessels that can be reconstructed by more than 5-10% are exceptional. What is more, pottery assemblages from many of the larger Neolithic sites comprise sherds from several different excavations, each with their own specialists, recording systems, and archiving procedures. As a result, special care is needed when sampling these assemblages for scientific analysis. Better understanding of how Neolithic pottery was used can also strengthen our sampling strategies. For example, it is widely accepted that the upper parts of a ceramic vessel will yield the strongest lipid signals, since fats and oils rise to the surface when food is boiled. However, this dataset indicated that fat residues are as prevalent further down the vessel wall, towards the base. I suggested that this is to do with the ways in which food was cooked; boiling with water may not have been the standard technique. On the other hand, lipids were better preserved along the rim of vessels. This has implications for both sampling and interpretation of results, and by taking this into account we can allow our fragmentary and finite evidence to guide scientific enquiry.

Such enquiry tells us that food and pottery were intimately connected in the Neolithic. Clay was dug almost exclusively for the purpose of making pottery, and pottery was made primarily for food processing. Pottery may have been considered especially appropriate for certain foods, such as milk and other dairy products. Over time, pottery was incorporated into the material culture repertoire of each community and potters began to make vessels that were suited to the ways in which food was prepared. We have also seen that each community had its own way of making both food and pottery. In other words, there is variation on the level of cookery and potting. On the other hand, these activities reproduced and drew on a wider food culture. This shared set of ideas about what was edible, how to eat it, and when, was manifested at seasonal gatherings. No change from the Early to Middle Neolithic could be discerned in the food residue data, although plant food signals are stronger in the earliest assemblage. This may reflect that carcass foods was a more frequent item on the menu later on and/or that pottery was gradually better adapted to cooking of meat and offal. This may or may not be related to the wider shifts in occupation; sites seem to have been occupied for longer periods of time and perhaps by larger groups of people in the Early Neolithic. A wider range of activities were undertaken at the Early Neolithic pit sites compared with the sites dating to the end of the fourth millennium. This returns us to the issues to do with the wider context of this project. I have argued that a focus on the interplay between communities with different food histories can help us transcend the immigrant-indigenous dichotomy to instead reassemble the fourth millennium BC in ways that are both scientifically sound and socially meaningful.

## Directions for further research

This project has generated a many further questions and it has brought to the fore certain areas that require more comprehensive archaeological attention. First, and perhaps most crucially, this research has exposed a poor grasp among archaeologists (myself included) of how food works. The materiality of food items such as milk or grain needs to be better understood. Literature and experience in other fields, along with experimental study of cookery with unglazed ceramics and in pits, could help redress this. In terms of pits, it is clear that there is some insularity in the study of British prehistoric pit features. Perspectives from elsewhere and from the ethnographic literature would help us better understand these places. Similarly, the growing evidence for largely pastoral economies in much of the fourth and third millennia BC requires further investigation. ‘Pastoralism’ involves a great deal more than tending cattle and drinking milk, but it is currently becoming a blanket term that supposedly explains what life was like in much of the Neolithic. If the Neolithic was largely ‘pastoral’ then we need to qualify that term theoretically and integrate it with our material evidence and scientific datasets. To do so, however, we need to abandon the belief that scientific data has the last word and to be wary of whether we are asking a scientific or an archaeological question. An example of the former would be ‘do chemical traces of food survive in these potsherds?’ whereas the archaeological question would ask what, if anything, such chemical traces tell us about life in the Neolithic.

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