

ARTICLE

Beyond binaries. Interrogating ancient DNA

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Abstract

In this paper we explore ancient DNA (aDNA) as a powerful new technique for archaeologists. We argue that for aDNA to reach its full potential we need to carefully consider its theoretical underpinnings. We suggest that at present much aDNA research rests upon two problematic theoretical assumptions: first, that nature and culture exist in binary opposition and that DNA is a part of nature; second, that cultures form distinct and bounded identities. The nature–culture binary, which underpins much aDNA research, not only is a misunderstanding of our world but also results in placing archaeology and material culture in a secondary and subservient position to science and aDNA. Viewing cultures as distinct and bounded creates exclusionary, simplistic and singular identities for past populations. This stands in contrast to the work of social scientists, which has revealed identity to be complex, multiple, changing and contradictory. We offer a new way forward drawing upon assemblage thinking and post-humanism. This allows us to consider the messy and complex nature of our world and of human identities, and demands that we expect equally messy and complex results to emerge when we bring aDNA into conversation with other forms of archaeological evidence.

Keywords: aDNA; assemblage theory; post-humanism; politics; identity

Introduction

There has been a florescence of interest surrounding ancient DNA (aDNA). New publications, drawing on large data sets from across Europe, appear to be shedding new light on old debates. From the transition to farming to the start of the Bronze Age, these publications are making waves within the discipline (Brace *et al.* 2018; Olalde *et al.* 2018) but also beyond, in newspaper articles, in blog posts (e.g. Last 2018) and in popular-science books (Reich 2018; Rutherford 2016), and producing fraught arguments at conferences. As an example, two recent publications make the central claim that aDNA demonstrates that the start of farming and the start of the Bronze Age in Britain were caused by the influx of migrants bringing new and superior technologies from continental Europe (Brace *et al.* 2019; Olalde *et al.* 2018). In the former case, Brace *et al.* (2019) argue that there is little biological continuity between Mesolithic and Neolithic groups, suggesting that overwhelming population replacement explains the transition to farming. In the latter case, Olalde *et al.* (2018) argue that the Neolithic population of Britain was replaced by an influx of migrants, again from continental Europe (though potentially with a more distant origin), who reduced the DNA signature of the indigenous Neolithic people to a tiny minority. Given the current political climate, including increasing nationalism, populist politics and refugee crises, it is little surprise that these arguments have generated so much attention both within and outside the discipline (cf. Brophy 2018; Frieman and Hofmann 2019; Hakenbeck 2019).

aDNA provides ammunition to a wider movement that sees recent advances in archaeological science as providing solutions to questions that have long puzzled the discipline. Kristian Kristiansen (2014), for example, has argued that archaeology is on the verge of a third scientific

revolution following the emergence of the discipline in the 19th century and the adoption of radio-carbon dating in the second half of the 20th century. For him, the new techniques ranging from aDNA to isotope analysis, from Bayesian modelling of radiocarbon dates to the impact of so-called Big Data, have dramatic consequences. Kristiansen (2014) claims these scientific developments offer archaeology the potential to escape theoretical debates and to provide an ever more detailed history of the human past (cf. Whittle 2018). The implication of Kristiansen's arguments (2014) is that the emergence of new scientific approaches renders the theoretical debates of the last fifty years null and void (cf. Sørensen 2017).¹ New data, it seems, remove the need for archaeological theory. The arguments in effect suggest that the problems with culture-historical approaches were not their theoretical shortcomings but rather the discipline's inability to answer the questions they were generating. At least on one level, it appears that some aDNA researchers seek to answer questions of the kind that culture historians posed (Carlin 2018, 35; Furholt 2019; Hakenbeck 2019) without consideration of why many archaeologists no longer ask those same questions.

Whilst we might be surprised that these new data return to the same old questions, we should not be surprised at the power that aDNA, in particular, has over our imaginations (cf. Ion 2017). As Strathern (2005, 167) recounts, when DNA was first discovered scientists were shocked by the hold it developed over the public imagination. In popular discourse we often refer to something as being 'part of our DNA' to mean something that is fixed, unchangeable, essential and inseparable from us. DNA is seen as defining who we truly are, as any number of ancestry websites are keen to emphasize (cf. Booth 2018). DNA is widely understood as a repository of all the important truths about people, including their histories and their predispositions to disease. Sequencing the first human genome was heralded as a critical moment in modern science and in the history of our species more broadly. Genomics has been used to define who is, and is not, human in the fossil record. The association that DNA carries in the public imagination with identity (of individuals and at species level), forged through a general understanding of its properties and its public presentation in fictional and real criminal justice, lends weight to the molecule as both biological entity and metaphor (Brophy 2018, 1653). Needless to say, such conceptions do little to engage with the complexity of DNA as a molecule or the nuance of research into genetics, but help to explain the public fascination with, and seeming explanatory power of, narratives that invoke its authority (cf. Horsburgh 2015, 141).

We too, of course, are impressed by the potential that genetic analyses provide for our discipline. Large-scale aDNA projects are not only producing a mass of new data; they are also taking 'old' archaeological data and offering new information. aDNA sequences allow potential new insights into the biological sex of skeletal remains, kinship relations, ancestry and health. In addition, because the largest aDNA laboratories are funded at levels unimaginable to most archaeologists, these projects are producing large numbers of new radiocarbon dates. It is clear to us that aDNA research is an exciting area of archaeological science and has the potential to contribute enormously to our understandings of the past. In this paper, however, we argue that for this potential to be reached we cannot simply position aDNA as a neutral arbiter of past identity but instead need, as with any piece of archaeological evidence, to situate it within a nuanced and theoretically sophisticated understanding of both past and present. As Eisenmann *et al.* (2018, 1) have correctly asserted, the 'exponential increase in the publication of ancient genomes ... has not been matched by the development of a theoretical framework for the discussion of ancient DNA results'.

In this paper we focus specifically on aDNA papers that are engaging directly with archaeological evidence. We are not seeking to reinterpret the findings of our aDNA-researching colleagues, or to unpick their methodologies. We are not going to wade into debates about sample size, selection or how representative a particular study is, nor do we seek to compare specific aDNA results with 'material culture' or isotopic data (Booth 2019; Eisenmann *et al.* 2018). Rather, we aim to build upon the important critiques of this approach which emphasize the

dangers of repeating the mistakes of culture history (see, for example, Furholt 2018; 2019), and the work of those archaeologists who have called for a more nuanced engagement between geneticists and archaeologists (e.g. Hofmann 2015; Johannsen *et al.* 2017; MacEachern 2000; 2012; Vander Linden 2016).

Beyond this, however, we identify three critical issues that we need to interrogate more fully if aDNA is to fulfil its potential as a critical tool for archaeologists both empirically and conceptually. First, we suggest that much aDNA research rests on a nature–culture binary that creates all manner of difficulties in situating it within the broader archaeological context. Over the last 20 years or more, many areas of archaeological thought have become highly critical of dualisms of this kind, precisely because they delimit and constrain our understanding of the past (e.g. Harris and Cipolla 2017; Thomas 2004). In response to this we will suggest that an approach to aDNA rooted in the perspectives of assemblage thinking (Jervis 2018; Jones and Hamilakis 2017, and papers therein) has more to offer us. Second, we suggest that most aDNA analysis rests on an understanding of identity and the human body that is profoundly essentialist, in that it relies on notions of singular and fixed identities that do not reflect the complexity of human lives, as studies of ethnogenesis clearly reveal (e.g. Cipolla 2013; Voss 2015). Here we suggest that a post-humanist approach to the body can open up more complex understandings of genes and aDNA as one critical element, but only one, of how past peoples' identities worked. Finally, we will suggest that the desire, on the part of both aDNA specialists and archaeologists, to produce narratives that fit all the evidence neatly together may in itself be problematic. Drawing on research examining the complex epistemic issues of integrating different forms of evidence emerging in other disciplines (e.g. Uprichard and Dawney 2019), and on an ontological approach to the past that emphasizes its multiple and relational, rather than singular and essential, nature, we suggest that we need to allow our different forms of evidence to contradict each other and speak to each other in complex ways (cf. Barad 2007).

One caveat before we move on. The world of aDNA research operates at different scales, and the description we have offered above, and much of what we discuss below, applies to studies that operate at large scales of analysis (e.g. Brace *et al.* 2019; Broushaki *et al.* 2016; Fu *et al.* 2016; Haak *et al.* 2015; Lazaridis *et al.* 2014; Lazaridis *et al.* 2016; Mathieson *et al.* 2015; Mathieson *et al.* 2018; Olalde *et al.* 2018). Other studies of aDNA offer far smaller scales of analysis, and more nuanced engagements with archaeological evidence (e.g. Haak *et al.* 2008; Keller *et al.* 2015; Lee *et al.* 2014; Le Roy *et al.* 2016; Knipper *et al.* 2017; O'Sullivan *et al.* 2018; Scheib *et al.* 2019) and have been, as Marc Vander Linden (2016, 718) has noted, much easier for archaeologists to engage with (cf. Thomas 2006, 51). In what follows we will mainly focus on the large-scale analysis, before turning to the small-scale at the end of the paper.

The theoretical tensions between archaeological and (large-scale) aDNA accounts

There are a number of tensions between archaeological and aDNA accounts. Perhaps the most significant critique that is emerging centres upon the relationship between aDNA analyses and culture-historical approaches (e.g. Carlin 2018; Furholt 2018; 2019; Hakenbeck 2019; Heyd 2017; Vander Linden 2016). This operates at several levels: some aDNA analyses focus specifically upon addressing similar research questions and themes to those that have been the traditional target of culture historians. Given the wealth of new data generated by aDNA research it is perhaps surprising that the narratives that are emerging from these studies are so familiar. Take the following quote:

A large-scale seaborne movement of established Neolithic groups leading to the rapid establishment of the first agrarian and pastoral economies across Britain, provides a plausible scenario for the scale of genetic and cultural change in Britain.

This could come as easily from Gordon Childe as from its actual origins in Brace *et al.* (2018, 6).² Just as Childe saw change in prehistory as a product of the movement of peoples bringing with them their material culture and practices, so Brace *et al.* (2018; 2019) see the emergence of the Neolithic in Britain as the product of the movement of groups of genetic signatures. Whilst in Childe's argument there was no necessary connection between the culture of a particular individual and their biological identity, though this was often implicit, Brace *et al.* (2019) make this link explicit. For those archaeologists who embrace more complex versions of identity (and indeed change), these arguments can seem reductive. After all, anthropologists have long demonstrated the issues with these concepts (e.g. Barth 1969), and we have had fifty years of archaeological critique of culture-historical models of the type that Childe put forward. Indeed, since the 1980s archaeology has embraced a multifaceted understanding of identity (Diaz-Andreu and Lucy 2005; Fowler 2004; Jones 1997; Voss 2004). Whilst both Brace *et al.* (2019) and Olalde *et al.* (2018) set out more complex scenarios in continental Europe, the models that they use to interpret the data in Britain clearly evoke culture-historical parallels. Indeed, these presuppositions more widely underlie aDNA research, as Martin Furholt (2018) has pointed out (see also Thomas 2006, 52).

There are three central assumptions that underlie both culture-historical research and the work of some aDNA specialists.³ First, it is assumed that identity is fixed at birth and consistent through the lifespan; if you are born a member of the Beaker people (whether that is culturally or genetically defined) you remain a member of that group beyond your death (cf. Furholt 2019). Second, these individual identities are strictly exclusionary categories; one cannot be both a Mesolithic hunter-gatherer and a Neolithic farmer (there is no intersectionality for culture historians or many aDNA specialists). Third, that change has two main sources – either diffusion or migration. Change comes from the outside and effectively involves replacement of one group of people (or way of life) with another that is technologically superior. For example, papers in the literature widely accept the replacement of one population in Europe by another at the start of the Neolithic, with various levels of admixture with the former group along the way (e.g. Brace *et al.* 2018; Lipson *et al.* 2017). Swiftly, however, this *description* of genetic change becomes seen as an *explanation* for what took place. For example, Lipson *et al.* (2017, 368, our emphasis) declare that 'ancient DNA analysis has validated major migrations from populations related to Neolithic Anatolians as *driving* the introduction of farming in Europe'. Historically it cannot be the case that the migrations drove the spread of farming, because migration is *in itself a historical event in need of explanation*. Thus Lipson *et al.*'s (2017) paper, which seeks explicitly in its title and methodology to explore the complexity of genetic histories, reveals how quickly linear, singular models of change become accepted.

Similarly, Allentoft *et al.* (2015) reveal at the close of their paper that aDNA research supports a 'correspondence between cultural changes, migrations, and linguistic patterns' in the Bronze Age. Although they caution that this cannot always be assumed to be the case, the fact that their paper begins with the declaration that 'by 3000BC, the Neolithic farming cultures in temperate Eastern Europe appear to be largely replaced by the Early Bronze Age Yamnaya culture' (Allentoft *et al.* 2015, 167) might lead the cynical reader to conclude that the research outcomes were predetermined by the sets of ideas imposed on the data from the outset.

Because genetic identity is elided with cultural identity here the notion that we can trace group movement through genetic sequencing is not in itself ever tested. As with the Allentoft *et al.* (2015) paper above, many aDNA papers do not look for genetic evidence that cultural groups existed in that past but rather work from that premise at the outset. As Martin Furholt (2018, 168; 2019) has demonstrated, there are a number of possible explanations for the genetic changes we see in Europe in the third millennium B.C. (see also Vander Linden 2016). Rather than embracing and exploring the multiple ways in which the Neolithic emerged even across as small an area as Britain, Brace *et al.* (2018) prefer to support a singular hypothesis (cf. Cummings and Morris 2018). As Horsburgh (2018, 656) highlights, we are at risk of sliding towards

hyper-reductionist thinking. There is complexity here as two worlds meet; for archaeologists, whose roots more firmly lie in the humanities, bringing out nuance, multiplicity and complexity are often *raison d'être*, whereas for some geneticists simplicity can be its own virtue (Booth 2019; Vander Linden 2016, 722). Recent papers, including those by Villanea and Schraiber (2019) on interbreeding between Neanderthals and modern humans, and Schuenemann *et al.* (2018) and Bos *et al.* (2016) on the spread of historical diseases, show this need not be the case.

Some authors have suggested that the argument that a selection of aDNA articles imposes an equation between people and culture is misleading (Eisenmann *et al.* 2018, 2). However, given the way this connection repeats itself across numerous papers, in addition to the manner in which the use of the data uncritically echoes culture history, we do not accept that this is the case. Furthermore, as Eisenmann *et al.* (2018, 6) emphasize, even where the connection between archaeological culture and genetic signatures may be debated, the existence of archaeological cultures, as unambiguous historical entities, is not in doubt. Interestingly, even authors who have explicitly argued that aDNA research will help launch a new scientific revolution (e.g. Kristiansen 2014) also present interpretations that are fundamentally culture-historical in nature (e.g. Kristiansen *et al.* 2017). aDNA papers in archaeology are not at the forefront of a return to processual archaeology, with models of population dynamics and critical hypothesis testing, as one might expect. Instead they presage a return to older forms of thinking.⁴

Data, regardless of the mechanisms through which they are produced, always remain theory-laden. There is no way out of an approach that hypothesizes the existence of bounded (and opposed) cultural identities in the past once you have started with that presupposition. As Lewis Binford (1968) and David Clark (1973, 15) demonstrated so clearly, these kinds of approach merely describe the data they encounter rather than seeking to explain the historical and anthropological circumstances through which they arose. What this shows is that generating more aDNA sequences will in itself not be sufficient to create more complex narratives of the past; instead what is required is a different approach to the data themselves. Tensions arise here because of the social and political power that scientific – and especially aDNA – narratives have (Horsburgh 2015). These narratives are accepted by the public, by some aDNA specialists and by some archaeologists as basic facts against which other kinds of evidence can be weighed. They are explicitly held up as something archaeology must be tested against (e.g. Brandt *et al.* 2015, 87) *and not the other way around* (Sørensen 2017, 101–102). Interpretations of aDNA present these data as neutral arbiters in a way that they could never be. They are a product of research strategies, sampling selections, statistical modelling, particular forms of presentation, generalization and expansion that reflect the aims and ambitions of the people generating the data (see, for example, Fujimura *et al.* 2014 on the effect of principal-component analysis). To be clear, that is not a criticism of aDNA research as against any other form of investigation; this is true of *all research in all disciplines* (Latour 1987; Shanks and Tilley 1987; Sørensen 2017). The issue is that its contextual nature is not embraced and acknowledged. These tensions thus create debates about how to get genetic and archaeological data to match (e.g. Eisenmann *et al.* 2018) or demands for more integrative ways of working (e.g. Johannsen *et al.* 2017, 1120). As we will see below, this tension reveals a deeper underlying reliance on binaries that requires attention, and a philosophical reconsideration.

The political tensions in aDNA

Before we move on to set out the philosophical critique of aDNA approaches, we need also to address the political and ethical elephants in the corner (see Frieman and Hofmann 2019; Hakenbeck 2019). Culture history is not simply problematic because of its presuppositions about identity and change. The model it rests upon also implicitly embraces a political position that reflects a reified version of 19th- and 20th-century Europe. All theory is of its time. This was

a world where people sought to clearly define the boundaries of nation states and the identities of those who lived within them, and it was a world where Europeans saw themselves as technologically and intellectually superior to their counterparts elsewhere. These approaches have been thoroughly critiqued and deconstructed through post-colonial theory (Bhabha 1994; Said 1978; Spivak 1988; Wolf 1982). Not only do such approaches fail to give adequate credit to the complexity of non-European civilizations, they also deny the always multicultural and multifaceted nature of all cultural groups (European or otherwise). Today, post-colonialism in archaeology brings to the fore the multiple and complex nature of colonial engagement; it emphasizes hybrids and creolization as well as highlighting oppression and resistance rather than discussing simplistic models of invasion and replacement (Battle-Baptiste 2011; Gosden 2004; Van Dommelen 2002; Voss 2008; 2015). As Furrholt (2018, 170) has argued, as long as our approaches to genetic evidence continue to rest upon these kinds of assumption, we risk lending spurious scientific legitimacy to nationalist politics. The utilization of culture history in the 1930s stands as a stark warning here.

The risk is not just in the political ramifications of the data and narratives we produce but in how we treat those with whom we work. It might be relatively uncontroversial to talk about different groups of Europeans 5,000 years ago, but it is not unproblematic to talk in the same way about the histories of those who have been victim to colonial oppression (cf. MacEachern 2012). This requires not only, as Mary Prendergast and Elizabeth Sawchuk (2018) have recently highlighted, consultation with local communities and the development of protocols for informed consent and the sampling of human remains for aDNA analysis, but also an understanding that the narratives we generate in the present can have significant political implications for people today. In David Reich's recent book on aDNA (2018, 163), he states that modern studies of DNA variation in Native American groups are a 'force for good' and makes it clear that he is frustrated at the lack of engagement from such groups. As Horsburgh's (2018, 657) review of the book highlights, not only does this fail to understand structural inequality, but furthermore Reich is not in a position to define what constitutes harm for indigenous groups. Anyone doubting the political salience of these points needs only to examine the recent debates around the US Senator Elizabeth Warren's DNA test and Native American ancestry (TallBear 2018; cf. TallBear 2013).

We thus welcome and support the developing critiques of archaeologists and geneticists that have flagged up key theoretical, political and ethical issues for working with aDNA (e.g. Frieman and Hofmann 2019; Furrholt 2018; Hakenbeck 2019; Horsburgh 2018; Prendergast and Sawchuk 2018; Vander Linden 2016; 2018, as well as the reflexive commentary of aDNA specialists themselves); however, as we noted in our introduction, we seek to take a different tack. Rather than further revisit the problems of culture history we suggest that we can also begin to deconstruct the philosophical approach behind aDNA research and offer an alternative.

Binary molecules, binary models, binary answers

A popular belief is that scientists discover the truth step-by-step and thus eventually produce bulletproof scientific facts. In practice, no matter how technically sophisticated, scientists try to fit observations into their systems of accepted myths and preconceptions.

(Bandelt 2018, 659)

Research into aDNA, like so much of archaeology, rests upon a series of binary oppositions (Harris and Cipolla 2017; Jones 2002; Thomas 2004). The opposition of cultural group and genetic signature maps neatly onto the classic opposition between culture and nature. In models of these kinds, nature is presented as universal and best understood through the mechanisms of science,

generating singular explanations. Culture, by contrast, is understood effectively to be an add-on, the purview of anthropologists and sociologists where cultural interpretations can be multiple and run counter to the ‘factual logic’ of Western science. This distinction also maps onto contrasts between ontology on the one hand (what the world actually is) and epistemology (what we think about the world), the former always singular and the latter always multiple (Alberti 2016).

This distinction between science as the singular truth and culture as the confusing multiple runs through the recent article by Eisenmann *et al.* (2018). The authors discuss how we might reconcile material culture (read ‘culture’) with genetic data (read ‘nature and science’) – the two stand opposed from the outset. Eisenmann *et al.* (2018, 6) comment that there is no ‘universal explanation for what stands behind an archaeological culture’. They also place material culture firmly in the secondary position when it comes to generating knowledge about the past – we must rely on material culture, we are told, when there are no eyewitnesses, sociologists or written sources that can tell us about group identity (*ibid.*, 6). As aDNA specialists remark, aDNA offers ‘a solid genetic framework against which archaeological and linguistic models can be tested’ (Brandt *et al.* 2015, 87; cf. Vander Linden 2016, 720). David Reich (2018, xx) has stated that ‘human genome variation has surpassed the traditional toolkit of archaeology’, and aDNA now offers ‘constraints’ to other forms of interpretation (Olalde *et al.* 2018, 194). It seems that there is not only a divide between nature and culture but also an internal separation between which explanations of culture are seen as superior.

These binaries go beyond nature versus culture; the genetic evidence is used to divide people neatly into opposed sexes with no consideration of the complexity of either biology or gender (Butler 1993; Robb and Harris 2013). Similarly, the groups detected provide little in the way of nuance when it comes to identity; people are either Anatolian farmers or Western European hunter–gatherers, as we noted above. Geneticists construct their groups using statistical methods that seek to gather together those who share more in common genetically than they do with others – this effectively creates an in-group/out-group situation – here there is no space for the person who both plants seeds and hunts deer. Given the way in which any person’s ancestry includes many people with whom they share no genetic overlap (Reich 2018, 37), this approach simplifies ideas of ancestry, descent, and identity to a level with which any social scientist would be deeply uncomfortable (Fujimura *et al.* 2014).

The simple fact is that when you start with binaries you are bound to end up with them. Furthermore, these binary distinctions are not scientific facts but rather inherited categories of thought (Latour 1993). For several decades now, philosophers, sociologists, anthropologists, critical thinkers and, indeed, archaeologists have sought to unpick the ways in which dualistic thinking has limited and delineated the possibilities for investigation and interpretation (Deleuze and Parnet 2002; Descola 2013; Latour 1993; 1999). Within archaeology, dualistic approaches were first denounced in the early 1980s (Hodder 1982), though they remained firmly part of the post-processual mode of thought. From the mid-1990s onwards, and particularly through the work of Andrew Jones (Jones 2002) and Julian Thomas (2004), dualisms have been the explicit focus of archaeological critique. In the last ten years archaeologists from a range of theoretical approaches from symmetrical archaeology (e.g. Olsen *et al.* 2012) to New Materialism (e.g. Conneller 2011; Jones 2012) have continued to undermine and deconstruct the effects that dualistic thinking has had, and continues to have, on our interpretations. It is notable that in response to this extended critique there has been little in the way of defence of dualisms: scholars either embrace the fact that this thinking is deeply damaging to our attempts to understand the past or simply ignore the argument against dualisms and carry on with business as usual.

As an example of how unhelpful binaries are, let us turn to DNA itself. DNA is often understood as nature embodied. What could be a more pure form of nature than our DNA? It is something that can only be revealed to us through science. Shaped by evolution, subject to the laws of biology, DNA, and the genetic information it contains, clearly fall squarely on the nature side of the nature–culture divide. On the other hand, though, consider this: your DNA is the product of social and historical

processes of both the short and the very long term. Ideas of class, race and nationality, all modern impositions, have shaped who people have reproduced with, where their descendants have moved to, and therefore people's DNA signatures (Roseman 2014). Over a longer time frame, many more historical processes come into play, including those that aDNA research purports to reveal, such as the spread of farming and the arrival of metalwork. Beyond this, however, DNA is a chemical that responds to the world in which it is enmeshed; as Ingold (2000) famously pointed out, the old biological maxim of genotype plus environment equals phenotype mistakenly imposes the idea that there is anywhere in existence a genetic sequence absent from its environment (cf. Pigliucci 2010). The human genome has not evolved, and does not exist, separately from what we might term 'culture'; the two are interwoven from the start. From our use of stone tools, to the ability of some of us to digest milk, via countless other mutations, alterations and transformations, human genomes are as thoroughly social as one could possibly imagine.

Why, then, continue to divide the world up into these binary categories? As Latour (1993) has shown, these oppositions are not merely present in the world; they are actively produced through a process he calls purification. People go to great lengths to make nature and culture separate from one another, and when such oppositions are threatened they can react violently. The reason why modern medical biotechnologies (which seem to endanger the sanctity of the human body) and the ever more apparent movement of people across national borders threaten people's understanding of the world is because of the way in which these challenge our dualistic oppositions (Robb and Harris 2013, Chapter 8). Patriarchal social structures rest upon the opposition of male and female and the association of the latter with nature and the body. A rejection of dualisms, therefore, is scientifically more accurate, politically necessary and ethically essential in the world we face today. Indeed, this complexity is recognized by many scientists, anthropologists and others working with biological evidence (e.g. Dunn, Reese and Eisenhauer 2019; Haraway 2008; Tsing 2015). Although it is beyond the purview of this paper, any attempt to challenge global warming will rest upon our ability to challenge the nature–culture divide (Latour 2018). Time, indeed, for something new.

Beyond binaries: post-humanism

Let us summarize, then, what our new approach to aDNA will require. First, it is clear that we need to situate our understanding of aDNA within an approach that does not divide the world into binary oppositions if we want both an accurate understanding of the past and to prevent the imposition of modernist ways of thinking. Second, we need an approach to identity that does not privilege a particular mode of being human (one all too familiar today), nor one that bounds the body off from the world around it. It is the radical separation of body from environment (another dualism) that reduces the body to the status of nature, and thus DNA to the essence of this nature. Finally, we will need an approach that does not allow one strand of evidence to ride roughshod over others. We cannot adequately understand the past if we continue to privilege specific forms of knowledge. This too would return us to a world of dualisms, and all the problems this entails.

In order to develop this approach, we advocate a framework rooted amongst the complex ontological positions beginning to be advocated across the discipline of archaeology (for a review see Harris and Cipolla 2017). Specifically, we suggest that we need to draw on elements of assemblage thinking (Deleuze and Guattari 2004; DeLanda 2016; Jervis 2018; papers that follow Jones and Hamilakis 2017, *inter alia*). This provides us with an apparatus for thinking through the past in ways that do not ontologically privilege science or humans, and allows us to move beyond binary thinking; we return to these ideas below. The related and compatible ideas of post-humanism (Braidotti 2013; Fredengren 2013; Harris 2016) emphasize the need for a non-dualistic approach to the world and to embrace and appreciate the diversity of humanity.

Whilst a full description of the multiple post-humanist approaches is beyond the scope of this paper, they share a rejection of the central tenets of humanism: that human beings hold unique ontological status. Furthermore, post-humanist approaches argue that only a certain subgroup of humans have ever been granted full membership of the human category (Braidotti 2013), that the world does not begin with prefigured entities (e.g. people and things) but rather emerges from relations, and that following from this we cannot artificially separate the world into neatly bounded categories such as nature and culture. For post-humanists, people and things emerge from a world of relations in which they are always already enmeshed. As we saw with the human genome above, no human being is born outside relations, and there is no relationship that can be easily categorized as either natural or cultural. Indeed, this is demonstrated by the work of ecologists and biologists in a number of different fields (see, for example, Cardinale *et al.* 2012; Dunn, Reese and Eisenhauer 2019).

This radically relational approach to the world opens up new ways of thinking about the inter-relationship of humans and animals (Haraway 2008), humans and things (Braidotti 2013), humans and flora (Ingold 2000), and humans and fungi (Tsing 2015). More than this, even, this approach to relations does not require us to include human beings at all, so it is not merely an approach that investigates relations between humans + *X* but rather forces us to jump into the middle of things, a web of relations which connect and produce the world. A flat ontology, which many post-humanists adopt, posits that all elements of the world emerge from relationships, including those that do not involve human beings. Such a flat ontology does not propose that all elements of the world are the same, but that we cannot understand the world by ontologically elevating the human category from the outset. Humans are undoubtedly different from buttercups, but buttercups are different from oak trees (cf. Dawney, Harris and Sørensen 2017, 122). It makes no sense to elevate one of these things to a unique ontological plane if we wish to understand how the world comes into existence. Furthermore, taking a post-humanist approach demands of us an explicitly political engagement with both past and present (Braidotti 2013). When the material being discussed and the interpretations produced are so potentially powerful politically, nothing less than a committed and engaged political stance will suffice. Simply burying our heads in the sand and proclaiming the protection of scientific objectivity denies the ever real presence of political power, influence, control and histories of complex colonial and post-colonial engagements. This is as true of studies of European identity, past and present, as it is in the contested world of Indigenous politics.

Such an approach has obvious implications for the human body. No longer seen as natural, bodies emerge from relations between a wide variety of entities. Our human body is not just the product of biology, but is shaped by the chairs we sit in, the foods we eat, the world we explore, the air we breathe, the plants that are in our offices, the other people we interact with, the microbes on our skin, and the animals we live alongside. This shaping is in no way simply cultural; it affects our skeletons, our muscles, our brains and indeed our DNA. As noted above, this shaping is both short-term (what a biologist would term acclimatization), medium-term (the plasticity of our body in response to action) and at an evolutionary timescale (termed adaptation) (Sofaer 2006). We are the product not just of our human genealogies but of a history of interactions with things from choppers in Olduvai Gorge, via Terra Sigillata in Rome, to iPhones today. There is no point at which our genome can be separated from our history, there is no point at which our genome is ever natural, and there is no point in this sequence when our genome stopped changing (cf. Ingold 2000). Not just humans either; the diseases that shape our bodies and population dynamics have their own complex genetic histories too (Bos *et al.* 2016; Schuenemann *et al.* 2018). This is to say nothing of the complex world of epigenetics (cf. Niewöhner 2011).

The human genome thus shifts over these multiple scales. Whilst we are used to the idea that genomes alter over the long term, from our very conception our DNA sequences are changing with potentially transgenerational consequences (Bjornsson *et al.* 2008; Jackson and Bartek 2009). Cell cycles produce occasional but regular mutations (Drake *et al.* 1998), changing the structure and make-up of our DNA sequences. Sunlight degrades the DNA in our skin; cigarette

smoke alters the molecules in our lungs. Within any human body there are countless organisms with their own specific genetic histories – there are bacteria that dwell in our guts without which we could not digest our food; there are microbes on our skin that help us fight infections; our interactions with animals leave their DNA signature within us, as the work of Donna Haraway (2008) so evocatively describes; the cells of other humans with whom we come into contact leave traces on the surface of our skin. The science of DNA fingerprinting, crucial to criminal procedures in the 21st century, rests upon the fact that bits of our DNA are left behind wherever we go. Bodies leak, and they are permeable.

DNA is thus an example of post-humanism par excellence; it is as far from the definition of individual human identity as one can imagine. Rather than revealing the pure essence of who we are, it discloses our deeply relational post-human histories, histories that include not just people but non-humans too. To be clear, we do not mean by this that the scientific analysis of aDNA specialists is somehow mistaken, or has identified the wrong DNA; rather, we take issue with the way in which these data are being thought about from the outset. Seeing DNA as the essence of our biology and identity is not only false (cf. Pigliucci 2010), but also serves as the basis for interpretations which continue to operate with a nature–culture divide wrought through their heart, and interpretations which continue to privilege science above all other forms of knowledge. It is not the case that we need to do the aDNA research again; it is just the case that we need to think about the data differently by starting from a different philosophical position. The irony is that the process of extracting aDNA demands cleanliness and purity and it seems that the interpretation of the results seeks this in the past too. The cleanliness of the lab is matched by the cleanliness of the science, yet both past identity and indeed DNA are far more complex than that. Whilst purity in the present may be necessary it can only be an abstraction in the past.

If post-human theory helps us to take a non-binary approach that radically decentres the human body as a bounded object, what might it do for our broader understanding of the way in which we integrate aDNA into our understandings of the past? To answer this, we need to turn to the assemblage thinking mentioned above (Jervis 2018). Assemblage thinking, developed from readings of Deleuze and Guattari, emphasizes that the world is not made up of bounded, fixed entities, but rather of temporary heterogeneous gatherings (termed assemblages) that are always in the process of becoming. Such an approach forces archaeologists to account for the processes by which assemblages come into being, and the forces that sustain them or cause them to fall apart. Assemblage thinking makes no distinction between matter and ideas, nature and culture or any other form of binary opposition. It has the great advantage of being both a theoretical approach that we can apply in the past, and a means of thinking through our practices in the present (Fowler 2013; Lucas 2012). This means we can use it not only to think about the assemblage of past identities (e.g. Harris 2016), but also to reconceptualize how we, as archaeologists, assemble our data into narratives about that past.

Approaching our data as an assemblage has three consequences. First, it refuses to place ‘science’ and ‘interpretation’ in differing ontological realms, with the former privileged over the latter (Harris 2014). Assemblage thinking famously begins with a flat ontology (DeLanda 2002). This means that we cannot take a position where our ‘subjective’ interpretations of ‘culture’ are tested against our ‘objective’ scientific facts, but instead requires us to attend to both these elements of the assemblage equally. Second, assemblage thinking emphasizes the relational, and multiple, nature of our evidence and of the world itself. Rather than demanding that we produce a singular story, where each element of the evidence matches the others, we can instead embrace a more complex and messy version where different lines of evidence tell us different things. Rather than demanding singularity, instead we have multiplicity; not one thing or the other, rather one thing *and* the other (cf. Deleuze and Parnet 2002, 57–59). Third, the consequence of this is that aDNA is one aspect of our data amongst many others. Whilst it is undoubtedly informative and important it should hold no special status.

In a recent analysis of mixed-methods research in the social sciences, Emma Uprichard and Leila Dawney (2019) have argued that one of the issues researchers face when integrating differing forms of data is the desire to always make the discrepancies vanish. Uprichard and Dawney (2019) discuss how the combination of quantitative and qualitative methods is viewed as a key advantage for the study of social phenomena. This can be seen as equivalent to the manner in which archaeology draws upon both scientific and interpretive approaches. It is common practice within the social sciences to appreciate the value of both the richly textured qualitative data and the robust quantitative data that mixed-methods research generates. Uprichard and Dawney (2019) recognize the necessity for mixed-methods research to capture the complexity, messiness and multiplicity of social data. Equally, however, they are critical of the ways in which scholars seek to flatten difference in order to produce singular and homogeneous accounts from their data. In contrast they urge researchers to embrace the messiness of the data, and to explore contradiction and tension rather than simply to suppress and ignore it. In a manner analogous to assemblage theory, they argue that multiple modes of data show us different aspects of the assemblage under study, and diffract and multiply what we can say about our object of research. As they state, 'although data integration is a sensible goal, we challenge the presupposition that it is necessarily the optimal outcome of mixed methods research' (ibid., 19, original emphasis). There is much to learn here for archaeologists. First, we need to embrace examples where our data contradict each other. Rather than presuming that one strand of evidence is faulty if it refuses to conform to others, we need to understand that the complexity of the past will always mean that there are contradictory stories to tell. Second, we need to acknowledge, again, that no one form of data, theory or interpretation can necessarily take primacy over others. Third, it also challenges the widespread suggestion that all will be well if archaeologists and aDNA specialists simply work more closely together (e.g. Johannsen *et al.* 2017) or develop a common vocabulary (Eisenmann *et al.* 2018, 2). No doubt there is much to learn on both sides. However, what Uprichard and Dawney teach us is that no amount of collaboration can be guaranteed to iron out difference, contradiction and complexity. More than this, we can recognize that the desire to remove this complexity is part of a wider attempt to construct visions of the past that deny ambiguity. Feminist scholars like Joan Gero (2007; cf. Sørensen 2016) have been deeply critical of such approaches.

Identity, so often the implicit focus of aDNA studies, is an inherently messy, multiple and contradictory subject. Research into identity frequently shows how we hold multiple and intersectional identities all at the same time. It also highlights how identity is not fixed but is always changing, in process, better considered as an event than a fixed essence (Puar 2012). It also shows that different aspects of identity come to be prioritized in different ways at different moments in time. Sometimes it is more important that we are archaeologists, at other times it matters more that we are siblings, parents or friends. One of the problems with the model of identity that aDNA researchers work within is that it prioritizes singular and simplistic understandings of what identity is. The complex nature of identity means that we will always require mixed methods to study it. For the archaeologist this means that aDNA data alone will never be enough; we also need close contextual analysis of material culture, architecture and the human body. The data here are unlikely to align, but rather than that being a problem it instead is revealing of the complex reality of past lives. More than this, however, as feminist philosophers like Rosi Braidotti (2013; 2019) have shown, a key aim of post-humanist approaches is not to focus upon the perceived majority at the expense of others, the minor stories that flow and interweave around dominant narratives that structure our understandings of the past (Braidotti 2011, 30–31).

Beyond this methodological issue, the commitment to complexity in our data and in our methods, in our embracing of ambiguity and contingency, also has political consequences. It is the privileging of one mode of knowing that has created so many of the problems we see around aDNA. It is not the case that simply working more closely with indigenous groups will mean they 'understand' why we 'need' to study their DNA (TallBear 2013). If DNA results reveal something surprising about your family background this is *only one* aspect of who you are, and not

necessarily a meaningful one (O'Sullivan *et al.* 2018; TallBear 2013). If aDNA says that people in Bronze Age Britain had large amounts of steppe ancestry, this is only one aspect of our understanding of both who these people were, and *who they thought they were*. DNA is no more truthful (or false) than any other element of the evidence we draw on to think about the past. Rather it is relational, formed in and through relations, studied in relation with archaeologists and scientists in the present, and can contribute to multiple narratives about the past. This call for multiplicity should not, however, be dismissed as mere relativism. Rather, as Deleuze and Guattari (1994, 130) argue, this is not about the relativity of truth, but rather the truth of relations.

Implications for aDNA research

To summarize our argument, it is clear that we need to adopt a post-humanist assemblage-inflected approach to the past if we are to understand aDNA outside the problematic binary oppositions that currently structure its interpretation in terms of both the approach towards science and the dominance of the nature–culture dualism. Such a move will also let us accept the inherent ambiguity and complexity of the information we can acquire about the past, and will allow our narratives to embrace rather than reject contradiction and difference. Thus rather than wobble between shifts in aDNA and broader changes in material culture, we would urge scholars to expect these different forms of data to rarely, if ever, align *perfectly*. These multiple forms of data show us different aspects of the past, and in particular their use to think about the inherently complex and multiple sphere of identity demands that we embrace intersectionality, complexity and diversity. Provocatively, we might suggest that scholars should be especially suspicious where shifts in material culture and society appear to neatly match changes in aDNA, because this may be revealing of the assumptions built into our models given the inevitable complexity of past societies. Processes of change are always messy and multiple, their effects are local and variable, and they eschew simplistic causation (Crellin 2020; Robb and Harris 2013). In contrast to the tendency of some aDNA researchers to want to interpret the data in the most straightforward way possible, we would urge researchers to embrace the search for complexity over simplicity. As Villanea and Schraiber (2019) demonstrate, multiple models can explain the same patterns of genetic ancestry. What would change in the past look like if we sought the *least* parsimonious explanation possible?

At the outset of this article we characterized aDNA papers as operating at either the large or the small scale, and have concentrated our argument on the former of these. Before concluding, however, we also want to think briefly about the theoretical frameworks that underpin small-scale studies as well. A number of papers dealing with individual sites and small-scale studies have emerged in the last ten years (e.g. Haak *et al.* 2008; Keller *et al.* 2015; Knipper *et al.* 2017; Lee *et al.* 2014; Le Roy *et al.* 2016; O'Sullivan *et al.* 2018; Scheib *et al.* 2019). These offer detailed and nuanced engagements with archaeological evidence alongside the aDNA, and in some cases isotopic data as well (e.g. Haak *et al.* 2008; Keller *et al.* 2015). These papers rest far less on assumptions about archaeological cultures and singular identities than do those explicitly operating at the large scale. The smaller data sets explored appear to leave space for the authors to consider more complex and potentially contradictory lines of evidence. Even where modernist concepts such as the nuclear family are invoked, these authors are careful not to make such a claim universal (Haak *et al.* 2008, 18229). In addition, rather than simply invoking migration, these studies explore more complex ideas of exogamy, patri- and matrilocality, and movement on a more local scale. Here we begin to open up access to the historical mechanisms that might produce grand narratives of migration.

Thus our paper could be read as an argument for sticking with these small-scale analyses alone, and a number of commentators have noted how much more easily these approaches fit with standard archaeological interpretations (e.g. Vander Linden 2016, 718). This, however, is not our position. As John Robb and Tim Pauketat (2013) have elegantly argued, it is not the case that we can

simply avoid the grand narrative and the politics that surround it. Robb and Pauketat (*ibid.*, 33) argue that we avoid the large scale at our own peril because if we, as archaeologists, do not engage with it, others will – others whom we might see as less informed and less engaged with the data and who, most likely, might have their own political aims. In a world where migration is never far from the newspaper headlines it is not the time to shy away from engaging with migration in the past (Frieman and Hofmann 2019). We suggest that we need to engage with the large scale and the grand narrative but do so in a way that integrates different scales of analysis. It is not the case that there is a correct scale at which to work; rather what we have to do is to combine both the local story and the grand narrative, alongside other scales of analysis.

Here again, assemblage thinking is helpful. Assemblages operate at multiple scales from the atom to the institution (Harris 2017; see also Crellin 2017). As Lesley McFadyen (2008, 307) argues, it is not the case that scales of analysis nest together like Russian dolls where either a top-down or bottom-up approach will work. Looking at neither the small scale nor the large scale provides the key. Rather, scale is more complex; DNA sequences could be seen as small-scale but the way in which they are shaped by processes that stretch across time and space means that they traverse scales of analysis in complex ways. Our aDNA interpretations need to do the same; they need to fold together multiple scales of analysis. If we want to talk about the ‘big picture’ or the ‘grand narrative’, that does not mean we should be avoiding the small scale, rather we should be folding that small scale into our analysis. It also means that simply accumulating more and more data to create an ever-larger scale of analysis is not the answer either.

As well as considering the narratives that emerge from aDNA research, we also call for a consideration of the process itself. Ethnographies of archaeology have revealed to us the complex ways in which we move from trowel’s edge to interpretation (Edgeworth 2012). Knowledge is produced in the small steps we take as we sample individual bones, as we extract their DNA, analyse the results, categorize them, bring them together with other analyses and piece this together in a narrative. It is clear from the work of both Lucas (2012) and Fowler (2013) that archaeologists themselves play key roles in the process of interpretation. As Bruno Latour (1999) has shown, these small steps matter; each act of ‘translation’ (in Latour’s terms) at once both amplifies and reduces some aspects of that which we study. We need to look carefully at these small steps and we need to think about which aspects of the narrative we are amplifying and which we are reducing in the process. It matters how we move from the sequence of one individual to a narrative about the past. Science and technology studies have been effective at revealing how scientific knowledge is produced and we see significant scope for ethnographers in aDNA labs to open up a key reflexive space for consideration.

Conclusion

aDNA research has the potential to provide an astonishing level of understanding about aspects of the past that previously appeared to be inaccessible. The work that dominates the debate is producing new and important data sets and opening up new vistas onto the past. However, as currently constituted, the theoretical approach to the majority of aDNA interpretation remains mired in assumptions inherited from the ideas of culture history. This is problematic not only because, as archaeologists have long recognized, ideas of bounded cultural identities are insufficient for understanding the past, but also because of the potential for these ideas to be deployed in damaging ways in the present (Frieman and Hofmann 2019; Hakenbeck 2019). Perhaps more fundamentally, this research fails to engage with the powerful philosophical critiques that have emerged across the humanities and the social sciences in the last two decades. The central opposition of nature and culture, which runs through both public discourse about DNA and research into its ancient counterpart, directly impedes an understanding of the world that does not impose modernist binaries that are ethically unsound and empirically questionable. Debates that query how genetic data relate

to cultural identity, or material culture more widely, miss the fundamental point that these two lines of evidence are not opposed to one another, like the double helix of DNA itself. Nor are they hierarchically ordered with nature providing the singular scientific facts of the matter, and culture being the purview of humanistic and contingent interpretation. Instead, aDNA and material culture are two material elements of the world amongst many others that are inextricably alloyed together. Indeed, what might happen if we treated aDNA as just another type of material culture, to be compared with the pots, bones, flints and plant remains we find alongside it? The lessons learned from Uprichard and Dawney (2019) are key here – archaeology’s multiple types of data from mixed methods should not be expected to align perfectly; rather we should be exploring their contradictions as it is in these contradictions that the messy reality of identity will be revealed.

Vander Linden (2018) suggests that the recent advances in aDNA research have the feel of a revolution (see also Booth 2018; Eisenmann *et al.* 2018; Furholt 2018; Kristiansen 2014; Reich 2018), but he is quick to note that, ‘like other scientific revolutions, there is a certain amount of stumbling and misunderstanding, as the power and limits of the technique are being tested’ (Vander Linden 2018, 657). Just as radiocarbon dating revolutionized archaeology (cf. Renfrew 1973), aDNA seems set to do the same (cf. MacEachern 2017). The emergence of the ‘radiocarbon revolution’ played a key role in the development of processualism as new theoretical frameworks became necessary both to deal with new kinds of data and to reflect the new understandings of the world that were emerging. In this paper we have argued that assemblage thinking and post-humanism can provide the sophisticated theoretical tools necessary to help us approach aDNA in a way that avoids a problematic view of culture and identity and allows us to dispense with damaging binaries.

In contrast to the dualisms that beset modernity, humanism and aDNA research, we follow in the footsteps of many recent archaeologists in proposing a relational and post-human approach. What post-humanism teaches us always to celebrate is what Anna Tsing (2015, 33) calls ‘contaminated diversity’: how different parts of the world burrow into one another, cross-pollinate and cross-fertilize. With its emphasis on statistically defined, bounded and homogeneous groups, the way much aDNA research is currently formulated belies the potential we have for exploring this contaminated diversity in the past. In contrast we suggest that a more radical, more exploratory, and more sensitive application of this stunningly powerful new tool has the potential to amplify rather than deny the diversity and differences of past worlds, and with it open up countless possibilities for reconceptualizing past identities. As Tsing (2015, 27) says, in a lesson to us all when considering the people of the past, ‘everyone carries with them a history of contamination; purity is not an option’.

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Notes

1 Similarly, Johannsen *et al.* (2017, 1120) and Vander Linden (2018, 658) both call for a return to hypothesis testing in archaeology, something that has a clearly processual flavour. It seems that scientific data call for scientific methodologies. There seems to be little reflection of why it was that many archaeologists moved away from hypothesis testing.

2 Interestingly, this quote was removed from the final published version of the paper, but remains present in the widely circulated and discussed preprint made available by the authors.

3 Whether or not aDNA specialists themselves believe they are studying identity is not the central issue here. Their research, when published, uses the language of identity, is associated with identity by archaeologists and is consumed as identity by the general public.

4 We are grateful to Julian Thomas for emphasizing the importance of this to us in his comments on a draft of this article.

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