

TOWARDS A NEW PARADIGM?

The Third Science Revolution and its Possible Consequences in Archaeology

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INTRODUCTION

There seems to be a general feeling that some fundamental changes are underway in archaeological thinking and have been for some time now. One need only look at some recent book titles such as *Death of Archaeological Theory* (Bintliff & Pearce 2012), *Paradigm Found?* (Kristiansen, Smedja & Turek 2014) or read the last two issues of *Current Swedish Archaeology*, where such changes were debated first from a philosophical/anti-theoretical perspective (Olsen 2012), and lastly from a natural science perspective (Liden & Eriksson 2013). Both ended with a somewhat pessimistic outlook, at least in my reading. Similar critical discussions can be found in other journals, and among the things they share are a critical stance against a previously predominant post-modern/post-processual hegemony, and the reintroduction of a revised modern/processual approach, whether in cultural heritage (Solli 2011), things and human relations (Barrett 2014) or in materialist and world system approaches (Galaty 2011; Rosenswig 2012; Earle & Kristiansen 2010). These discussions, however, are not confined to archaeology, but reflect a broader break-up in the social and humanistic disciplines. The question has therefore been raised if we are moving out of the postmod-

ern age, in archaeology most recently discussed by Fredrik Fahlander (2012). He concludes that the future holds the answer, but that something is about to change.

I shall now provide a different, more optimistic perspective on the future of archaeology than that of Olsen and Liden, in which I link fundamental changes in archaeological, science-based knowledge and the increasing application of Big Data to necessary changes in archaeological methods, interpretations and theory. The prospects of these changes, I shall argue, open up a new chapter in archaeological knowledge that demand similar changes in archaeological methods and theory, some already underway, some still to be developed. This I shall exemplify first by a historical comparison and then by tracing some recent research trends. My point is that such a “from below” perspective grounded in an ongoing data revolution may provide a better foundation for understanding where we will be going. In conclusion I raise the question whether we are heading towards a new “paradigm” or if we are entering a “post-paradigm” period. Finally, I ask if this puts new demands on the relation between archaeology and the public domain.

RECENT THEORETICAL TRENDS AND THE THIRD SCIENCE REVOLUTION IN ARCHAEOLOGY

One of the major critiques launched by post-processual archaeologists against processual archaeology some thirty years ago was its reliance on natural science methods with its implied regularities, quantification and modelling of data. It was termed a “dehumanization” of the past by Shanks and Tilley (1987:77), and for the next two decades quantitative methods and science-based knowledge more or less vanished from archaeological interpretation. Instead agency-based, contextual interpretations took the front seat. Those who did not feel at home in this post-processual world of hermeneutic and phenomenological understanding of the past verged towards biological evolution and its application to archaeology as “Darwinian archaeology” (Shennan 2002) or proceeded to develop Social Evolutionary/ World System and Marxist approaches (Kristiansen 1998; Kristiansen & Rowlands 1998). I diagnosed and discussed this divergence ten years ago (Kristiansen 2004), and shall now take another diagnostic look at these trends to see where they have taken us in the meantime.

To begin with we need to recognize that the situation today is fundamentally different from ten years ago in three important respects:

- We have witnessed the breakthrough of the next generation of sequencing of ancient DNA, which took A-DNA studies out of their 20-year-long stagnation and is now rapidly producing new, often surprising evidence on human origins and expansions (Rasmussen *et al.* 2010, 2011 and 2014; Skoglund *et al.* 2012 and 2014). For the first time it is now possible to produce genomic data rather than the very limited mitochondrial DNA, which has nevertheless yielded interesting information about major changes in the genetic composition of Europeans during the Neolithic. New haplogroups were introduced, some pointing to possible origins in the east, others in the Iberian peninsula. By the Bronze Age these changes were completed (Brandt *et al.* 2013; Brotherton *et al.* 2013; Kayser *et al.* 2009, Lalueza-Fox *et al.* 2004; Ricaut *et al.* 2012). However, with the prospect of studying full genomic diversity and comparing prehistoric genomic data from western Eurasia in real time as is done in my own European Research Council project “The Rise” (WWW.the-rise.se) in collaboration with the Centre for GeoGenetics in Copenhagen, and the Centre for Textile Research, we are reaching a new stage in explaining genetic diversity from prehistory to the present, and in defining population changes and bottlenecks which can then be compared to other forms of archaeological and historical evidence. In addition we have seen extensive application of various isotope analyses, where strontium from humans and animals informs about mobility and diet, and where lead analyses of metal, especially bronzes, is now able to locate the origin of copper, which chemical analyses had not been able to. There is still some way to go before these scientific landmarks are fully calibrated and precise, but the accumulating effect of their scientific applications to archaeology is no less than monumental, and only comparable to the effects of radiocarbon dating from the 1950s onwards. We have to rewrite prehistory once more, allowing for much more mobility than ever imagined just ten years ago.
- We have witnessed the formation of the European Research Council (www.erc.europa.eu), which for the first time has allowed the financing of basic research on a grand scale, including humanities and social sciences, and with a special programme for junior researchers as well. It has already had a rather large impact on the formulation and financing of projects on a European scale, which would have been difficult to carry out within the framework of national research councils, with few exceptions. Some of these projects will be referred to later. The long-term effect of the ERC funding will be profound, and will allow research projects that are able to cope with

the ongoing data revolution in archaeology. It also supports a new generation of young researchers who grew up in the digital age and who are just as familiar with complex computer modelling as they are with the latest critical theory. The prevailing opposition between science and humanities, theory and data, is thus disappearing in my vision of the future.

- Finally, we have witnessed the silent collapse of the dominant post-processual framework, as it did not account for the kinds of evidence we have seen emerge during the last ten years. And neither did the processual framework. In short: we are in a period of theoretical and methodological experimentation and reorientations, where everything that was “forbidden” research 10–15 years ago are now among the hottest themes: mobility, migration, warfare, comparative analysis, evolution, and the return of grand narratives. Bjørnar Olsen described his feeling of this collapse of normal post-processual agendas with gripping passion: “It is decaying and withering, exposing a ruin landscape interspersed with cracking black boxes. And with a slight shiver of *déjà vu* running through my body, I started to thinking the unthinkable: that a new revolution is underway; more silent perhaps, but also more radical and different than the previous ones”. (Olsen 2012:18). It could not be better expressed.

Where will these new trends take us? What does the future hold for archaeology? It may be profitable here to look back at archaeological history, as it indeed provides comparative evidence of a related nature.

HISTORICAL PARALLELS

First parallel 1850–1860

The formation of archaeology as an independent discipline was closely related to its collaboration with zoology and geology. Thus the period 1850–1860 saw the parallel, and related, scientific breakthroughs of cultural, biological and geological evolution. It paved the way for a period of systematic data collection and methodological ordering of data headed by Oscar Montelius. New typological and chronological systems of knowledge emerged that established a new understanding of human origins in prehistory that replaced biblical accounts. Evolution became the theoretical, comparative framework. Science and ideas of progress went hand in hand, and established archaeology as a scientific discipline. This paradigm was challenged around 1900 and replaced by a cultural-

historical attempt at explanation, headed by Gustav Kossinna, the first theoretical archaeologist

Second parallel 1945–1955

A hundred years later, another scientific breakthrough occurred with wide-ranging consequences for archaeology. The period 1950–1960 saw the breakthrough of nuclear power and the related method of C14 dating in archaeology. It paved the way for a reorientation of archaeological interpretations, and the assimilation of new scientific methods of analysis from biology (pollen analysis), geography (settlement models), chemistry (trace analyses) etc. During the 1960s it gave rise to the science-based New Archaeology and Neo-evolution. This science-based paradigm was challenged by a culture-historical revival during the 1980s, under the banner of post-processual archaeology.

Thus, both revolutions were later followed by a theoretical critique leading on to a more humanistic and culture-historical archaeology with less emphasis on science. If, however, we look a little more closely into the background of these two scientific revolutions, we see that they share certain traits (Kristiansen 2003): they were both foreshadowed by an initial phase when interdisciplinary experiments were carried out and some of the prospects of the new applications were discussed in cutting-edge international research environments. This was then followed by a breakthrough phase when the new results were universally embraced and redefined their disciplines, such as geology and zoology during the period 1850–1860. This, however, was soon to be followed by a critical consolidation phase where shortcomings were analysed and corrected, as with the C14 calibration curve. But before applying this triple sequence to the present, let me first briefly examine what is left of mainstream theory.

WHERE IS THE MAINSTREAM?

What we have witnessed during the last ten years is the collapse of a shared – or mainstream – theoretical framework. It has dissolved into a multitude of methodological and theoretical experiments, which is indicative of changing perceptions of the past, and probably also our own society. This is happening at a time when material culture and materiality studies have gained a foothold in the related disciplines of ethnology, anthropology and history, reflected in the *Journal of Material Culture*. At the same time, increasingly esoteric theoretical models with minority status are formulated in archaeology – from the ontological infusion

of “Being” into things, freed from human dominance (Olsen 2010 and 2013), to the application of biological evolution to cultural transmission (Shennan 2009; Mace, Holden & Shennan 2007). They represent two radically different theoretical solutions to the interpretation of objects and their meaning, but perhaps less incompatible than they may look at first sight. Both approaches have been subject to serious critique more recently (Barrett 2013 and 2014; Anderson 2014; Hodder 2013), and from here there seem to emerge new theoretical possibilities of integration. Thus, to me there can be little doubt that a wedding of aspects of materiality/thing theory and evolutionary theory is necessary in order to reassemble some of the theoretical spoils of the recent meltdown of the dominant paradigms. There are already attempts to provide a way out. Ian Hodder’s book *Entangled* is an attempt to restore materiality and evolutionary theory some of the mainstream attraction it lost by becoming too esoteric. He provides a “theory lite” with clever use of case studies, mainly from Catalhöyük. Although alluring, it is not able to transcend the dichotomy between his “micro” archaeology with high empirical resolution and the larger “macro” archaeology, combining all data rather than a single site. But no doubt it represents an important step forward in terms of a more holistic theory of the micro level in archaeology, with attempts to connect to the macro level. In addition, materiality studies have increasingly been adopted to account for larger-scale phenomena in situations where it is possible to focus on a specific material institution, such as traders, or some specific properties of the material record (Maran & Stockhammer 2012; Earle & Kristiansen 2010; Fahlander & Kjellström 2012).

Mobility has by now become a mainstream research theme, and in my book with Thomas Larsson, *The Rise of Bronze Age Society*, we provided a new theoretical and interpretative framework at the macro level in the first two chapters (Kristiansen and Larsson 2005). We wished to reinterpret the larger archaeological configurations that made up the interconnected globalized world of the Bronze Age, and which set it apart from the previous Neolithic (Kristiansen & Larsson 2005; Kristiansen in press). Globalization as a general phenomenon that may appear under various historical circumstances is also increasingly being applied to prehistory (Jennings 2011; Vandkilde 2008), and we have seen a whole series of books and articles that apply a moderate or modernized version of evolutionary and world system approaches (Beaujard 2012; Hornborg & Crumley 2007; Galaty 2011; Kradin 2002). To this belongs a return to systematic comparative studies (Earle and Kristiansen 2010; Smith 2011) with Ian Morris grand narrative: ‘Why the West rules – for now’, as an influential example. It is based on a quantitative comparison of

east and west Asia (Morris 2010), and in a follow-up book Morris explained the methodological approach and the parameters used for comparison. An intelligible reintroduction of quantified comparison (Morris 2013). It represents an expanding trend among younger researchers to apply quantification, various forms of modelling and simulation to be discussed.

To sum up: among these diverse theoretical strands we see a reformulation of both former processual and post-processual approaches, from quantification and agent-based modelling to micro archaeologies of materiality studies. Ecological approaches are likewise coming back under the banner of sustainability and human ecology (Isendahl & Stump 2014). Where will this take us?

EXPANDING FIELDS OF NEW KNOWLEDGE

I shall now exemplify some recent developments linked to the third science revolution in archaeology. They are in the fields of (1) “Big Data”, (2) new quantitative modelling and (3) results from A-DNA, strontium isotopes and related scientific methods.

1. *The power of Big Data.* The concept of Big Data has become a hot issue in the last decade. National and international research councils allocate huge sums of money for so-called “infrastructure” projects, which basically means funding large research databases and making them accessible. To archaeology this is nothing new, we always relied on national and regional databases from systematic surveys carried out during the last 150 years, and we were among the first to digitize and make them accessible on the web, e.g. in Denmark (<http://www.kulturarv.dk/fundogfortidsminder/>). What is new, however, is the universal demand to making research data accessible, such as the global genome databank, which has demonstrably speeded up genetic research on a global scale. Digital Humanities is another concept referring to the new potential of analysing huge amounts of digitized data, whether in literature, on the web, in news, archives etc. Here mention should also be made of the universal digital access to all forms of geographical and other spatial data employed in GIS modelling. In archaeology we should mention the C14 database published by Radiocarbon (see also www.jungsteinsite.uni-kiel.de/radon/radon/), but also an increasing amount of more specific data is being made available, such as rock art (www.shfa.se). Finally, we need to recognize the hugely increased knowledge database archaeology

can muster compared with the situation 40 or 50 years ago. After 40 years of contract archaeology, real historical knowledge about settlements and landscapes is possible. After the third science revolution, museum collections are becoming revitalized as new evidence can now be extracted from them, just as they are becoming increasingly available for research in databases. All of this invites a re-theorizing of the archaeological record and its history (Lucas 2012). From this follow also new methodological/analytical developments.

2. *The methodological power of quantification and modelling.* Following on access to large datasets, we see new quantitative methods being applied more widely among young researchers in the form of agent-based modelling and network analysis, to name two of the most popular (Barton 2014; Kowarik *et al.* in press; Lake 2014; Verhagen & Whitley 2012). But also palaeobotanical research has seen a breakthrough in landscape reconstruction by combining regional and local pollen diagrams over larger regions in a new computer model called “Reveal”, with real world correction factors for landscape reconstruction (Gaillard *et al.* 2010; Nielsen *et al.* 2012). We are also beginning to see joint European projects financed by the European Research Council, projects taking advantage of Big Data, such as Alistair Whittle’s “The Times of Their Lives: Towards Precise Narratives of Change for the European Neolithic through Formal Chronological Modelling” (<http://totl.eu/>), or Stephen Shennan’s “The Cultural Evolution of Neolithic Europe” (www.ucl.ac.uk/eurevol). Shennan and his team have provided new proxies for population fluctuations by employing tens of thousands of C14 dates from the European Neolithic to trace a possible demographic decline or bottleneck around 3000 BC (Shennan *et al.* 2013; Shennan 2013; also Hingst, Sjoegren & Müller 2012). From the recent genome from Ötzi the Ice-man we know that he lived around this time and has a very few relatives among modern Europeans, mainly in Sardinia (Keller, A. *et al.* 2012). Something dramatic happened after 3000 BC in Europe. By combining high-resolution micro case studies with macro data from archaeological databases it has also become possible to reconstruct absolute population and settlement numbers and calculate resource use in the Bronze Age (Holst, Rasmussen, Kristiansen & Bech 2013). Finally, network analysis has once again come to the forefront of archaeological methodologies, as a means of expanding materiality studies with powerful new analytical techniques and a broader theoretical repertoire (Mizoguchi 2009; Knappett 2011, 2013).

3. *The theoretical power of new knowledge.* The theoretical wedding of agent-based materiality studies/Actor Network Theory with quantitative analytical techniques may be seen as an attempt to overcome the dichotomy of macro versus micro theory: the structural/top-down constraints of world system theory, with its related concepts of institutionalized interaction (Kristiansen & Larsson 2005, chapter 1), and the analytical/bottom-up constraints of personalized, agency-based materiality theory of things and humans (Fahlander & Kjellström 2010; Knappett 2005; Johannsen 2012; Olsen 2010, 2013). Network analysis seems to provide an attractive interpretative “tabula rasa” for a multivariable approach with free moving agents – material and human – at the forefront. It further attempts to integrate both micro and macro perspectives into a scalar approach (Knappett 2011; Earle & Kristiansen 2010: Figure 1.3). This is in line with recent theoretical attempts to bridge the gap between a materiality approach whose success has mainly been at the micro level, often in rich historical/and or archaeological contexts (Meskell & Joyce 2003; Knappett 2005) but now also more widely applied, e.g. in classical archaeology (Maran 2011, Steel 2013), with new insights from the ongoing science revolution in archaeology, such as strontium isotope analysis and A-DNA. So far results of the latter have demonstrated that human mobility was much more profound in prehistory than previously assumed (Knipper & Price 2009), not least in the Bronze Age (Price, Knipper, Grupe and Smrcka 2004; Chenery & Evans 2012; Linderholm 2008; Linderholm *et al.* 2011; Pokutta 2013; Wahl & Price 2013). Therefore migrations, travels and other forms of interaction and mobility have come to the forefront of archaeological interpretations and debate (Cabana & Clark 2011, Dziegielewska, Przybyła & Gawlik 2010; Krenn-Leeb *et al.* 2009), and the first attempts to synthesize new results from A-DNA on a European scale have surfaced (Manco 2013). The theoretical and historical implications of this knowledge revolution will be profound, as it lifts the forces of historical change away from the local context onto a much larger geographical scale of multiple local interactions, creating a constant flux of connectivity and productivity without fixed boundaries.

Where do these new trends take archaeological theory and interpretation? And where in the triple process mentioned above are we at present?

NEW FIELDS OF (RE)THEORIZING

If I were to compare the third science revolution in archaeology with the second, the radiocarbon revolution, then we are now where C_{14} was before calibration. In strontium isotope research we are beginning to get a more detailed, high-resolution background of baselines to identify origins in some regions (Frei & Price 2011), and when it comes to A-DNA we are learning more about the conditions for DNA preservation, the best places to sample human DNA (teeth, hair, or some specific small ear bones), but we are only starting to get a comparative database in real prehistoric time. In strontium isotope research we have also witnessed expanding applications in other materials, such as wool, hair, etc. (Frei *et al.* 2009; Frei 2014; Bergfjord *et al.* 2012), in order to trace the origin of textiles/wool, and the life and diet of individuals during their last years in life (sampling hair when preserved). The Iceman Ötzi may provide a good example of this biographical approach (Muller *et al.* 2003), and when part of his genome was published recently we also learned that he has few relatives among modern Europeans, mostly confined to Sardinia (Keller *et al.* 2012).

While it is possible to define new fields of theorizing, it is impossible to predict where this will take us. Let me therefore start with a discussion of what I consider new fields of knowledge in need of critical theorizing as well as currently expanding fields of new analytical techniques. I have summarized my view in Figure 1 in the form of a theoretical wheel to symbolize the main theme of mobility and how it is analysed and theorized. The central part, the axle of the wheel, is occupied by the main research theme during the next two decades: interactions of all things movable (humans, animals, objects, raw materials etc.) and the networks they move through, whether through trade, migration, colonization or other forms of movements. Mobility and interaction draw their data from many fields: strontium and lead isotopes, A-DNA, but also archaeological data on trade, migration and other forms of interaction. Here we have seen new analytical developments, e.g. network analysis and other forms of interaction (Knappett 2013; Nakoinz 2013).

To analyse and theorize mobility and interaction I have paired a number of theoretical or methodological concepts as spokes in the wheel forming dialectic axes. Landscape modelling and settlement modelling represent the man-made landscape dynamics and how this is structured over time, which also includes demography, household economies and other basic variables. The development of new advanced modelling tools for landscape reconstruction, such as Reveal (Nielsen *et al.* 2012; Gaillard *et al.* 2011) provides a new framework for interactive settlement

studies and modelling (Diachenko 2013; Robb 2012), including agent-based modelling (Cimler *et al.* 2013). But the calculation of absolute demographic figures is now also within reach, and can be used in comparative studies of demographic and economic/environmental development (Müller 2013).

Agent-based modelling and complexity theory is closely related, but where agent-based modelling is about concrete analytical strategies complexity theory informs about structural relations, causations and thresholds of more complex systems (Barton 2014; Kohler 2011). In the same field simulation models are also coming back (Lakea 2014), just as we have seen a real expansion in the application of agent-based modelling recently (Wurzer, Kowarik & Reschreiter 2013).

The next dialectic in the wheel is that between genetics and culture. This has already been subject to much discussion, but earlier publications were based on modern DNA from which deductions were made backwards in time. We are now beginning to produce prehistoric genomic evidence that opens up several new fields of research: it will allow un-

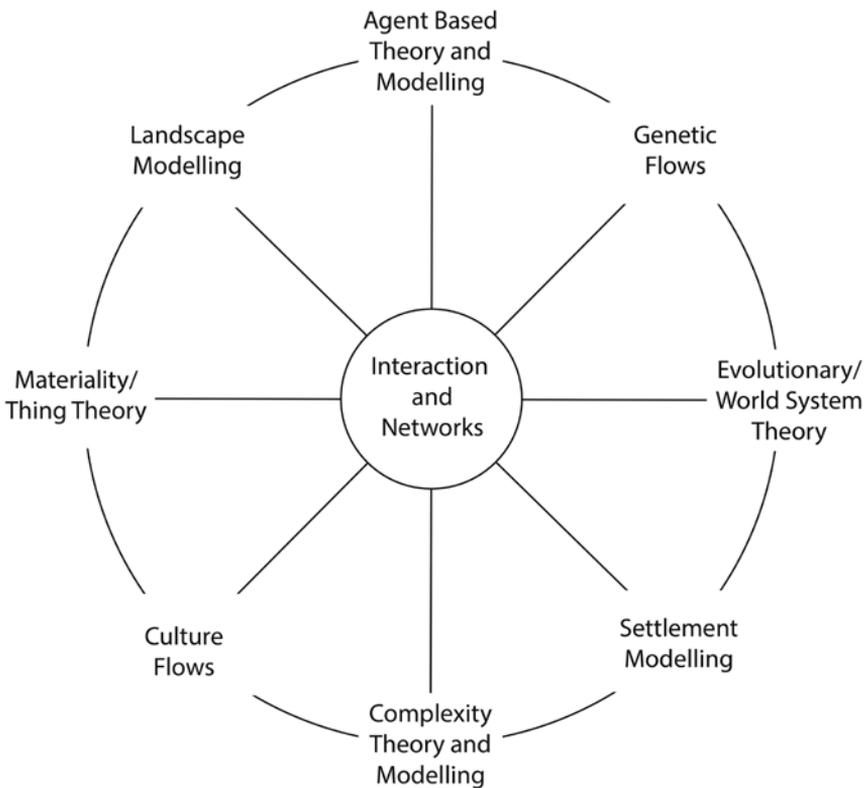


Figure 1. The theoretical wheel, suggesting new axes of theorizing.

precedented insight into genetic variability in real prehistoric time, which can then be compared with modern DNA, and thus form the basis for a genetic history (Pinhasi *et al.* 2012). It will allow the reconstruction of migrations and other ways of renewing the gene pool, which apparently took place several times during prehistory, but especially during the later Neolithic/early Bronze Age in western Eurasia. And when compared with relevant archaeological data and cultures it will allow critical analysis of how the two interact. Recent work on the construction and meaning of cultures and ethnicity (Hu 2013; Roberts & Vander Linden 2011) will thus be amplified. This will inevitably lead to critical discussions about genetic and cultural interaction and transmission. In addition we shall be able to trace human diseases, lactose tolerance, eye and hair colours etc. (Vuorisalo *et al.* 2012).

All of these analytical results should ideally also be interpreted from a materiality/evolutionary perspective as it provides social models with historical time depth. Evolutionary and World System theory remain strong interpretative models in both North America and Russia, and we have seen refinements as well as new results that accounts for much of the diversity we find in prehistory (Bondarenko, Grinin & Korotayev 2011; Grinin & Korotayev 2011; Hall, Kardulias & Chase-Dunn 2011). Also, the ongoing discussion of the relationship between biological and cultural/social evolution shows the attractions and strength of such an approach (Anderson 2013; Barrett 2013; Cochrane & Gardner 2011; Hodder 2013).

THE FUTURE OF ARCHAEOLOGICAL THEORY: TOWARDS A NEW PARADIGM OR PARALLEL MAJOR AND MINOR PARADIGMS?

A paradigm is a shared foundational set of theoretical beliefs and priorities that govern the way one or several disciplines interpret their data. When Thomas Kuhn introduced the concept in 1962 for the natural sciences (Kuhn 1962) it was soon applied in archaeology to characterize the major changes in thinking from cultural history to processual and later to post-processual archaeology. However, several researchers later argued that paradigms, or discourses to use the French concept, are much more encompassing and relate to the way humanities and social sciences interact with society throughout history. Major shifts in theoretical and philosophical priorities have thus oscillated between “modern” and “postmodern”, or “rationalistic” and “romanticist” perceptions of the world since the Enlightenment (Friedman 1994; Wolf 1999;

Kristiansen 1998: Figure 14; Bintliff 2008). In the words of Eric Wolf: “Tracing out a history of our concepts can also make us aware of the extent to which they incorporate intellectual and political efforts that still reverberate in the present” (Wolf 1999:22). He sees the original debate between Enlightenment and its enemies as having formed all subsequent debates. Or in his own words: “Each encounter provoked reactions that later informed the position taken during the next turn. The issue of Reason against Custom and Tradition was raised by the protagonists of the Enlightenment against their adversaries, the advocates of what Isaiah Berlin called the Counter-Enlightenment. In the wake of this debate Marx and Engels transformed the arguments advanced by both sides into a revolutionary critique of the society that had given rise to both positions. The arguments put forward by this succession of critics in turn unleashed a reaction against all universalizing schemes, schemes that envisioned a general movement of transcendence for humankind. This particularism was directed against Newtonian physics, Darwinian biology, Hegelian megahistory, and Marxian critique, on the debatable premise that they all subjugated the human world to some ultimate teleological goal” (Wolf 1999:22).

There is, in my opinion, little to suggest that we are past these classic debates and shifts in ideological and intellectual climate. I therefore tend to see the present changes in archaeology as part of a larger shift from postmodernity to a revised modernity. If this were not the case we should instead consider the third science revolution as inherently archaeological, which it is not: the DNA revolution of human genetics penetrated and redefined not only medicine but many natural science disciplines as well, and also indirectly influenced the social and historical disciplines. Here the parallel computing and digital revolution in modern media and communication also had huge impact by creating Big Data. This combined data and knowledge revolution is thus interdisciplinary and global, and therefore changes observed in archaeology are also likely to be observed in other disciplines. There are, however, two conditions that influence the course of the new paradigm, and whether it is still possible to maintain a dominant global position. It is the relation between the “dark” and “bright” side of globalization, and it is the specific position archaeology holds between science and the humanities.

Paradigms/discourses were defined in the past as relating to a dominant global condition, whether modern or postmodern (Friedman 1994). This implies that there were marginalized regions, such as former eastern Europe under communism, which was cut off from such global developments, or disciplines with minority status, which lacked the critical mass and importance to enter the global cultural and intellectual trends. In

the present we are faced with uneven economic development resulting in a “dark” (neo-nationalism) and “bright” (expanding global welfare) side of globalization. We may therefore also expect this to have an influence on the acceptance of new theoretical ideas, and a more sceptical approach in some academic camps towards the third science revolution and its impact. In addition to this, archaeology occupies a specific position among the social and historical disciplines, between science and the humanities, which may suggest a stronger acceptance of the science revolution than in other social and humanistic disciplines.

Archaeology is concerned with long-term history, as well as its constituting sequences of short-term history and personal lives. The A-DNA and strontium revolution redefines human origins, health and mobility, and establishes a new prehistory. A more holistic theoretical approach must be developed to account for this new diversity, one that integrates micro and macro perspectives – from human life stories (A-DNA/strontium) to their larger social/cultural framework (travels/interaction/networks/major genetic shifts). One such example is Eulau in central Germany: a cemetery of what turned out to be several family groups. The DNA analysis could demonstrate that children buried together with a man and a woman were their offspring. But in addition the strontium isotope analyses revealed that the males were local but the women were non-local, originating in a nearby, but different Neolithic Culture. The arrowheads used to kill some of the buried were also from this “other” culture. Here the combined evidence from A-DNA, strontium isotope analysis, osteological analysis of skeletal trauma and archaeological analysis of flint arrowheads revealed an ancient drama of potential wife robbing and later revenge (Meyer *et al.* 2009; Meller, Muhl & Heckenhahn 2010). The reconstruction of such a singular historical event is powerful as it opens the door to social and political dynamics and tensions on the ground, which, however, were played out and should be situated in the larger context of the expansion and consolidation of the Corded Ware culture among neighbouring and retreating Neolithic cultures during the third millennium BC. Here future genomic DNA analyses will be able to reveal how this happened.

Thus, the ongoing scientific revolution of archaeological knowledge has implications for theory and interpretation, as well as critical thinking. When the contours of this new prehistory become clearer we will see new theoretical and interpretative models emerge, and I have suggested what they may look like (Figure 1). Prehistory will thus in some situations be subject to the same level of detail as modern material culture studies. This opens up for a truly human history from the Palaeolithic till today, and a truly interdisciplinary understanding of human history.

It will require the development of a critical archaeology that engages in a discussion of biology vs culture, genetic versus cultural evolution. However, we are past theoretical hegemonies in the humanities. What we will see is rather a heavier reliance on large datasets, whether from micro or macro studies, as exemplified by Ötzi the Iceman or the victims of a third-millennium drama in Eulau, and more complex modelling. This invites theorizing that is more integrated in actual modelling, such as agent-based modelling or complexity theory. Some will see this as a return to a more processual, positivistic approach, which may in part be true, but it is one that is also informed by critical theory about the use of the past. It will therefore be more engaged in political and ethical issues. This new discourse is emerging already, but will become dominant during the next decade. We may still see part of the post-processual agenda continue in some camps, and critical heritage studies will keep expanding and thus force archaeology to confront political issues about the use of the past. Let me therefore finally, and very briefly, discuss archaeology and the public domain.

TOWARDS A NEW PUBLIC ROLE FOR ARCHAEOLOGICAL AND HISTORICAL RESEARCH?

During the last generation we have tended to separate the public domain of archaeology from its scientific domain: the public domain was relegated to cultural heritage, which represents a reworking of the past in the present, whereas academic research was considered to be about the past, even if its relation to present concerns and questions was acknowledged. Museology likewise became the professionalized management of collections and exhibitions, and taught as courses along with cultural heritage at universities. During the last decade or so both fields have developed critical academic research: we talk of Critical Heritage Studies (CHS), and Critical Museology, dealing with the formation of collections during European imperialism and colonization. They have also developed their own journals (*Journal of Heritage Management*, *Critical Heritage Studies*, *Public Archaeology*), and an international association (Association of Critical Heritage Studies: www.criticalheritagestudies.org.preview) – a sure sign of a more mature field of research and management. This professionalization and critical development of new fields of archaeological engagements and research was necessary, but tends to obscure the close relation between the three: new knowledge about the past has implications for how we present the past in museums and at public monuments, and questions of identity, nationalism,

political uses of the past cannot be completely separated from ongoing research, which has become painstakingly clear with the influence of ultra-nationalism on research in many regions of the world (Shnirelman 1996). A recent example is the attempt by (ultra-nationalist) Indian researchers to claim that Indo-European languages had their homeland in India (see debate articles in *Journal of Indo-European Studies* vols 30 and 31). Very much in the way Gustav Kossinna wanted a Nordic homeland for Indo-European a hundred years ago, based on ideological conviction. There are no easy solutions to such ideological infiltrations, other than maintaining high-quality, critical research programmes.

Another area of debate that has resurfaced, as exemplified by Liden and Eriksson (2013), is that of the “Two Cultures”, as originally presented by C. P. Snow in his classic lecture from 1959, later published as *The Two Cultures and the Scientific Revolution*. We are now in a similar situation, where science has taken a big leap forward in archaeology too (just see how the *Journal of Archaeological Science* has increased its annual issues in recent years). Thus the natural science turn in archaeological knowledge during the last ten years left archaeological theory, as well as most archaeologists, somewhat baffled and behind. There emerged a situation where biologists took centre stage and wrote popular syntheses about human and social evolution, such as Brian Sykes’s *Seven Daughters of Eve* (Sykes 2001), presenting to the general public a mitochondrial Eve located in Africa, or the hugely popular books by the biologist Jared Diamond (1997 and 2006), which tended to simplify things in a dangerous, deterministic way. A scientist recently came to the defence of the humanities in the book *Aping Mankind* (Tallis 2012), against what he considered the misrepresentation of humanity. However, the debates that have followed point to another dimension of modern DNA research: it raises fundamental questions about what it means to be human, what genetic variation means, and the prospects of such knowledge for ideological propaganda, whether racist/anti-racist, nationalist or anti-nationalist. In short: it demands a stronger public engagement by archaeologists, scientists and humanists, perhaps to a degree we are not used to. While archaeology has a long and glorious history of popularization, there is less experience of taking part in critical public debates, whether in newspapers, television or on the web. Here Germany has a special tradition of “Historikerstreit” about crucial questions linked to the world wars and what came after, but the humanities and archaeology in particular need to engage in discussing the implications of the expanding frontier of knowledge just described, from A-DNA and genetics to the diet and mobility of individuals, from demography to sustainability in the long term. The archaeologist as a

public figure was the theme of a recent volume of *Archaeological Dialogues*, presenting some relevant papers and examples from around the world (Tarlow & Stutz 2013).

I would like to see new forms of academic engagements with the public that cross-cut our professional domains. I do not recommend a return to a Romantic past where the polymath and antiquarian was a central figure, as illuminated by Michael Shanks (2012; see also mshanks.com - blog - all things archaeological, one of the earliest in archaeology), but we can follow Shanks in taking this historical figure as a parable for our need to engage more holistically with the past and its role in the present and future (also Otto & Bubandt 2010), and in the process we need to find new forms of such engagements, from blogging to online histories that are revised and expanded on a daily basis. It can take the form of national histories, European histories or gender histories, immigration histories etc. The sky is the limit. But this would also demand a revision of the role of the historian/archaeologist/intellectual as a publicly engaged figure, and a redirection of funding towards new forms of public engagements. Books, like vinyl, will continue as a physical, analogue format, but we need to explore in a scientific way the many new possibilities of engaging with the past in the present.

THE MOST EXCITING OF TIMES

I shall end this diagnostic and predictive essay on a personal note. I feel that we are right now experiencing the most exciting of times in archaeology – at least during my own lifetime. The 1950s must have held some of the same excitement, at least for some: suddenly you could walk back into the museum stores and select material for absolute dating. A dream fulfilled. Like now: we can once again walk back into the museum stores and select material that will tell us whole life stories of individuals, their diet, mobility and close family stories, as well as their larger genetic family stories from prehistory until the present. A new door has been opened to previously hidden absolute knowledge that once again will reduce the amount of qualified guessing and thus both refine and redefine theory and interpretation.

Is there more knowledge of similar magnitude stored to be unleashed from the archaeological record? We know that DNA is stored in frozen soils and perhaps in other soils under good conditions of preservation, which if successfully applied to archaeology could open the door to full environmental reconstruction, including animals and humans (Hebgaard *et al.* 2009). My own unfulfilled dream is that one day we shall

be able to release the sounds of prehistory: talking, music etc. stored in some mysterious way in the atomic particles of pottery and metal during the process of their production. It will probably never happen, but the point I wish to make is that innovative research is fostered by dreams about what the past was like and how we can find new ways to get to know about it, and secondly what we can learn from it in the present. This dialogue between dreams and hard evidence, past and present concerns, keeps research going during the long, laborious and unglamorous weeks, month and years in the laboratory, in the museum stores, and at the excavations. At least it does for me.

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