Chapter 1
Into the Tangled Web of Culture-History and Convergent Evolution

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> "*The question "how common is convergence?" remains unanswered and may be unanswerable. Our examples indicate that even the minimum detectable levels of convergence are often high and we conclude that at all levels convergence has been greatly underestimated.*" (Moore and Willmer 1997, p. 1)

Background and Context

The themes explored in this book revolve around the related areas of convergent (independent) evolution of particular forms of material culture, the notion and recognition of populations in prehistory, and issues of taxonomy (such as 'technocomplexes' and 'industries') that archaeologists debate as the subject moves (generally) beyond culture-historical interpretations. Another recent volume explored convergent evolution in lithic technologies (O'Brien et al. 2018a). My aim here is to complement such research and push it into debates on 'populations' and archaeological taxonomy across space and time. In the first part of this introduction I describe the background and context of this volume. I subsequently describe the individual chapters.

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Firstly, some comments on definitions. By convergent evolution we mean the appearance of the same (or very similar) features of material culture in different places due to their independent invention. This is opposed to similarities reflecting either population movement or the spread of ideas by cultural diffusion. These poles are often described using the biologically-rooted terms of 'analogy' (convergent evolution) and 'homology' (similarities due to relatedness). While 'homology' in the archaeological record reflects relatedness and connectivity, and therefore offers insights into how human societies moved through space and changed through time, convergent evolution has the potential to severely disrupt and complicate these narratives, by falsely implying connections that never occurred.

Convergent evolution is common in biology, and has been much discussed (e.g. McGhee 2011). As McGhee pointed out, while Darwin concluded *On the Origin of Species* by stating "from so simple a beginning endless forms most beautiful…have been, and are being evolved" (1859, p. 490), it is actually doubtful whether "endless forms" is a particularly accurate way of looking at things. Similar features have repeatedly evolved, in diverse lineages, over millions of years. Ultimately, convergent evolution is so frequent in biology because of 'evolutionary constraint', "that is, the number of evolutionary pathways available to life is in fact not endless, but is quite restricted" (McGhee 2011, p. xi). Some scholars distinguish 'parallel evolution', which can be seen as a special example of convergent evolution where a trait emerges in two groups from the same ancestral state, rather than truly independently (McGhee 2011, p. 3). In 'normal' convergent evolution, two different traits evolve into two traits which are similar/the same, whereas in parallel evolution one trait evolves into two similar traits, which both appear independently, but from a common base. It is also possible for convergence to stem from 'reverse evolution', when a trait evolves to a similar condition to earlier in its lineage, and where the original form may be preserved in other branches. For the

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present purpose, 'parallel evolution' and 'reverse evolution' can be considered variants of general convergent evolution. In future examples, however, it may be useful to distinguish these different processes in cultural settings.

The importance of convergent evolution in biological evolution is clear. Eyes—to give one particularly iconic example—have appeared independently at least 49 times (McGhee 2011). But what about convergent evolution in cultural evolution? When it comes to early prehistoric archaeological evidence we are mostly dealing with stone tool data. There are powerful reasons to expect convergent evolution here. Unlike forms of material culture where recycling is possible (e.g. metal), lithic reduction is a one-way process. And the nature of this one-way process is constrained by specific fracture mechanics, rooted in physical processes that are fairly well understood (e.g. Cotterell and Kamminga 1987, 1990; Tostevin 2012; Lin et al. 2018). As Eren et al. (2018, p. 70) put it, you "cannot strike a spherical flake". The 'design space' of possible stone tool technologies is actually reasonably small, and the chances of convergent evolution therefore high. Similarly, early humans would have used tools for a limited number of tasks—such as cutting and scraping—and this relative homogeneity of function would also likely have been a powerful driver for the re-invention of particular aspects of material culture. If something as complex as agriculture was invented independently in several parts of the world at broadly the same time, then surely different ways of producing stone tools are also likely to demonstrate myriad examples of convergent evolution. And we can imagine different forms of convergent evolution: such as those which are similar by random chance and those which are similar due to strong 'pragmatic' factors (such as microlithic technology, as explored by Clarkson and colleagues (2018).

'Culture-history' refers to a distinct archaeological tradition that has interpreted and understood archaeological 'cultures' as corresponding to distinct human populations that have long associations with particular regions. This understanding of the archaeological record has emphasized distinct ethnic identities with simple, linear histories. There are often modern political aspects driving the promotion of culture-historical accounts, such as nationalism. Culture-historical approaches tend to be built on inductivism, and downplay the diversity of factors structuring the archaeological record and its complicated relationship with identity and genetic structure. Convergent evolution, for example, is a serious impediment to notions that finding a particular form of pot, or stone tool, automatically equates to a particular group of people. While many archaeologists have developed processual and post-processual approaches to studying the past, culture-history remains a significant school of thought in archaeology, albeit often somewhat disguised and packaged in different ways. The contemporary idea of the 'Nubian Complex', for example, is classically culture-historical in its construction (see Groucutt 2020). Various publications have explored the character and history of culture-historical interpretations in archaeology (e.g. Lyman et al. 1997; Trigger 2006).

Finally, the notion of 'population' deserves some thought. The idea of population is central in genetics, and is also widely used in various human sciences (e.g. Krieger 2012; Kreager et al. 2015a). The term population comes to us from the Latin *populus,* which refers "generally to people living in a state, but more particularly to citizens" (Kreager et al. 2015b, p. 25). In that sense the origin of the word population is a group of something in a particular place.

Since the time of Aristotle and other early scholars, the meaning of the term has changed and developed. In biology the term population tends to be used to describe a geographically and temporally delineated group of individuals belonging to some higher-order taxonomic category (such as a species). In its application in genetics, there is much more complexity than the old idea of the *populus*. There is, for example, the notion that over relevant timescales, populations display panmixia, that is all individuals in a population mate at random with other individuals in the population (e.g. Wright 1984). The reality of course is that to varying degrees, mating in populations is not random. This leads to some interesting ideas, and it has been claimed that "were sufficiently detailed data available, every individual would be a 'population'" (Lawson 2015, p. 109). In genetics, programs such as STRUCTURE can be used to statistically define populations. This is a rather different perspective on the notion of populations than those used in subjects such as history and geography. More discussion needs to occur on how different disciplines are using the concept of populations, and explore the extent to which groups defined by different disciplines/datasets actually correlate with each other. Given growing arguments for admixture in hominin evolution, do traditional definitions of population remain useful? Such questions require much thought and discussion.

In human evolutionary studies, the role of demography (that is, broadly, the study of the sizes, 'shapes' and connectivity of populations) has been prominent in some narratives (e.g. Powell et al. 2009). A recent study on the evolution of *Homo sapiens* by Scerri and colleagues (2018) emphasizes the importance of population structure in the evolution of our species. Diverse datasets are consistent with this model, while many previous analyses have assumed (or at least implied) panmixia (i.e. random mating between individuals in a population) at vast scales (such as the whole of Africa). Modeling high levels of population structure is complex and computationally demanding, but nevertheless is emerging as being essential to understanding the human

past. Things become even less clear when poorly-defined populations are glued to poorly-defined aspects of variability in the archaeological record described in terms 'industries' or 'technocomplexes'. Overall, Krieger (2012, p. 635) is surely correct that the "population sciences need to expand and deepen their theorizing about who and what makes populations". This should be a significant aspect in prehistoric archaeology and related fields over the coming years.

Archaeology on the Rocks

Most of the contributions in this book focus on variation in lithic (stone tool) assemblages. This should hardly come as a surprise given that in their temporal span, abundance and preservability, lithics dominate the early prehistoric archaeological record.

Lithic analysis is strongly divided between different schools and research traditions. While there is methodological disagreement, we would also do well to recognize that sometimes there is more commonality than we realize. Lithic analysis as a whole has generally moved from 'static' (often typological) to 'dynamic' (often technological) notions. This could also be seen as a move from a focus on objects to a focus on processes. Dynamic perspectives vary in form considerably. Despite claims to the contrary, many similar ideas are found in the Anglo-world 'reduction sequence' approach and in the French-originated chaîne opératoire school (e.g. Shott 2003). While combined analyses with different approaches and backgrounds are rare, those which do exist are highly significant and deserve careful study (e.g. Scerri et al. 2016) Views of lithic reduction as 'dynamic' also come in many forms, such as Dibble's (e.g. 1987, 1995a) notion of scraper form changing with retouch intensity. My personal perspective is that all approaches to lithic analyses have good and bad points. We should focus on taking what works well to answer particular questions, and not on defending particular research traditions that we happened to have been raised in.

We can think about lithics in terms of the 'static' forms that we find in archaeological sites, and the 'dynamic' processes which produced them. The way to distinguish similar forms may be to differentiate the processes that produced those forms. Yet, conversely, detailed analysis of static forms may be the way to distinguish between superficially similar processes producing them. Just as the distinction between 'stylistic' and 'functional' features is blurry, so the distinction between static and dynamic conceptions breaks down under analysis.

Traditionally, lithic analysis and archaeology in general focused on describing forms, such as in typological frameworks. In the later twentieth century this tended to fade somewhat as the field shifted towards a focus on process. Yet with the current rise of geometric morphometrics (GMM) approaches, we are in essence seeing a return to a focus on object form (in the guise of detailed thought on shape), albeit at a higher level. I believe that care is needed with 'morphocentrism', as Charboneau (2018) put it. Charboneau (2018) pointed out that these approaches have been useful in some ways, but also have limitations, such as their inability to deal with novel forms (rather than subtle variation). Likewise, even to the extent to which 'shape' is important, it is complicated by factors such as differential reduction intensity and does not correlate with transmission mechanisms in as pure a way as something like a gene does. Aside from issues such as whether lithics have any meaningful 'landmarks' for GMM analysis, we must question whether highly detailed analyses of subtle variations in shape are going to provide satisfactory answers to the questions we wish to ask. Yet, we should celebrate the focus on data, objectivity and replicability in such approaches.

One cannot deny the dynamism bought to archaeological accounts by process-centered accounts (such as those of the chaîne opératoire school), yet we should also recognize their limitations. How does one quantify and compare inferred processes (and any higher-level interpretation requires inference)? In my opinion a focus on process means that the archaeological record increasingly consists of a series of highly detailed assemblage studies—with abundant refits, use-wear analyses and so on—which float in space and time and are poorly articulated with other assemblages. Answering the key questions in human evolutionary studies require comparisons across time and space, and comparing processes has not proven easy. Building comparative frameworks should be at the heart of methodological development.

In my opinion then, we have to find a balance between studying forms and processes. There are ways this can be done, such as the framework developed by Tostevin (2012) and extended into multivariate analyses by Scerri (e.g. Scerri et al. 2014). We need strong theoretical frameworks. And we have to separate historical contingencies from essential characteristics. The tendency of chaîne opératoire advocates to reject quantification, for instance, can be seen as a reaction against the pseudo-quantification (e.g. cumulative graphs) of Bordes (Soressi and Geneste 2011). Likewise, it is possible to believe in 'evolutionary archaeology' and find particular methods such as cladistics problematic. More broadly, 'tree-like' models of the past may seem intuitive, but it is not clear how accurate or helpful they are (Groucutt et al. 2015a; Scerri et al. 2018). Human prehistory is not like a family tree.

It is also interesting to observe ongoing debates about methods in other fields. For example, there is currently a debate raging in the study of dinosaurs. Baron and colleagues (2017) proposed a major revision of the dinosaur

cladistic structure (phylogeny). Others have criticized this argument and present alternative cladograms (e.g. Langer et al. 2017). The point is that, despite decades of study, the field is currently up in the air. As Benton (2019, p. 83) puts it, "this might sound shocking, or an indictment of the cladistic method". He defends cladistics, seeing the only alternative as "assertion and guesswork". This example should surely give us food for thought on the utility of cladistics. It is possible that the dinosaurs rapidly split into different groups early in their evolution, and this, along with convergent evolution, makes distinguishing the deep relationships challenging. These debates should warn us against the view that because cladistics 'works' in biology then it will work in archaeology. Likewise, criticisms of the chaîne opératoire approach (e.g. Dibble 1995b; Tostevin 2011) should be carefully evaluated by proponents of that school, not simply ignored.

While critics of 'evolutionary archaeology' have long argued that there is so much horizontal 'blending' that it is illusory to imagine cultural change in a tree-like manner, it is arguably true that as Buchanan and colleagues (2018, p. 275) put it "numerous studies have now shown that blending is not more prevalent in culture than biology". However, such views can be taken in different ways. For example, while I agree that the dominant mode of cultural transmission is vertical inheritance, the importance of occasional horizontal transfer and convergent evolution (invention) should also not be underestimated. I have no problem with 'evolutionary' processes, and while I think the dominant themes of the archaeological record do reflect inheritance, it is never the less true that if one day a lion decides it wants to be a donkey, it is probably going to be disappointed when the sun sets, whereas if a blade-maker wants a handaxe, they may well be able to achieve their wish. Just as with evolution, gradualism (or even stasis), may dominate in terms of time spans, yet sudden changes and convergent evolution cannot be downplayed. Key aspects of material culture may appear precisely at moments of major transition and turbulence. One can measure thousands of flakes in multiple dimensions, but if a fundamentally new element emerges—groundstone technology, for example—that data is not really going to help to clarify things. My point is not that 'evolutionary'/phylogenetic approaches to lithic analysis are not useful, but simply that, in the grand sweep of time and space, they are perhaps not sufficient. With particular questions, in particular study areas, they have their uses.

Numerous examples in this volume outline the limitations of a 'morphocentric' approach. If we think, for example, of the 'Clactonian' assemblages discussed by McNabb (2020), they are both preceded by and followed by 'Acheulean' assemblages featuring iconic handaxes. Understanding the place of the Clactonian is not going to be helped by detailed analyses of handaxes, as these are not a significant part of Clactonian assemblages (if they are present at all). So it is only by rounded technological analyses and consideration of chronostratigraphic issues that such themes can be addressed.

Context and Chronology

Let us step back from the details of different analytical frameworks for studying lithic assemblages. One thing I would like to emphasize is that we should always consider the extent to which technologies/assemblages actually are similar, before we move into complex discussions on why they are similar. For example, different assemblages from the Levantine Middle Paleolithic are often described as being 'the same'. This is discussed as an interesting example because these assemblages are made by both Neanderthals and *Homo sapiens*, and thus the apparent similarity in lithics through time feeds into negative views on whether lithics can actually tell us anything at all. My view is that there is actually no time-transgressive 'Levantine Mousterian'. Assemblages are broadly similar, as we would expect from closely related groups occupying the same kind of environment, and within the 'mode-3' world of subtle variations in core reduction methods and tool types. In my opinion, when one looks in detail the Middle Paleolithic assemblages of the Levant are not 'the same' at all (e.g. Groucutt et al. 2019). McGhee (2018, p. 27) goes to considerable lengths describing the apparent mystery of convergent evolution in the Levantine Middle Paleolithic, which he sees as a very exciting example of "iterative evolution that is both parallel and convergent". In my opinion, this unnecessarily complicates the situation.

Before we move into sophisticated analyses we should make sure that our starting premise is actually meaningful. The same could be said of purported similarities in 'microlithic technologies' in southern and eastern Africa and South Asia (Mellars et al. 2013). Yet, again here it should be pointed out that on multiple levels of technology, as well as other aspects such as chronology, these examples are simply not very similar (e.g. Groucutt et al. 2015a, b; Lewis 2017; Clarkson et al. 2018).

Numerous other debates and issues swirl around the areas we are discussing. For example, correlations between form and function remain very problematic. This is, for example, explored by Douze and colleagues (2020) in their consideration of 'points'; a category which subsumes a lot of technological and morphological variability. The importance of dating is paramount, particularly chronometric dating. And in fact, it could be argued that many of the problems we face today reflect chronometric issues. Unfortunately, archaeology has a propensity to appeals to authority, and if one is firmly wedded to an idea it is possible to argue why

'x' site is too far away to be important or why 'y' dating sample should be ignored. We should of course be critical of all chronometric age estimates, but where they seem to be reliable, they should be central to our accounts. Without time, the archaeological record is a mess.

As numerous papers in this book argue, good chronological control is absolutely vital. The development and refinement of absolute dating techniques is central, and should be a continued target for funding and research. Single amino acid radiocarbon dating, for example, promises a major advance (e.g. Devièse et al. 2018). For earlier periods the use of techniques such as optically stimulated luminescence often results in prodigious error ranges, yet they are often the only option available. Understanding the strengths and weakness of different techniques and age estimates is central. For example, it is important to emphasize that a minimum age is a minimum age, not an approximation of a specific age. It is also important for archaeologists to improve their understandings of the strengths and weaknesses of different models, not simply to act as passive consumers. One need not spend months measuring grains of quartz in the dark to understand that the kind of model chosen has a fundamental impact of optically stimulated luminescence dating techniques. If a paper therefore gives minimal information—such as not saying whether the central age model, minimum age model or finite mixture model was used—its results should not be relied on. And it should be made clear that such practices are not acceptable. Likewise, as Reynolds (2020) discusses, it is important to understand the outlines of different radiocarbon pre-treatment methods. Attempting to remove contamination from collagen, for example, is not straightforward. Many published radiocarbon estimates may be wrong. And it is often very hard to distinguish contamination from sources such as humic acids in soils. If at all possible, multiple, independent dating techniques should be used to give more certainty. Techniques such as Bayesian modelling are useful, but if the underlying dates are flawed they will only create artificial certainty. Finally, as Reynolds (2020) argues it is precisely by weaving together technological and chrono-stratigraphic information that we can build reliable frameworks. If a site represents a remarkable exception from an otherwise clear pattern, it may well be published in a high-impact journal, but it may also be the result of problems such as incorrect dating.

Converging

Being able to distinguish convergent evolution from other mechanisms is crucial in understanding the meaning of the archaeological record. The example of the long-lived Acheulean is interesting here. While likely to be provocative, Shipton (2020) makes a strong case that the Acheulean does not represent the repeated invention of similar technologies, but rather is a genuine cultural tradition. Shipton (2020) uses comparisons of lithic data, experimental knapping, and consideration of chronometric age estimates to make his argument. Whatever one thinks of his conclusion, Shipton (2020) is surely right to highlight these kinds of approaches as the way to address the issue of convergent evolution.

Other chapters in this volume highlight numerous examples of actual or probable convergent evolution. In doing so they join many examples already discussed in the literature. The presence of stone tool making in several distantly related species of primates likely reflects convergent evolution (e.g. Carvalho and Beardmore-Herd 2019). In more recent periods numerous examples exist. For example, most researchers think the view that 'Solutreans' crossed the Atlantic to settle the Americas (e.g. Stanford and Bradley 2012) is highly unlikely. It is much more likely that superficial similarities—particularly 'overshot flaking'—reflect convergent evolution due to similar technological repertoires (bifacial flaking) (e.g. Eren et al. 2013, 2014). Other examples that many archaeologists would accept as representing convergent evolution include the origin of Levallois technology (e.g. Adler et al. 2014) through to particular retouched tool forms such as tanged/pedunculated tools (e.g. Scerri 2012) and fluted points (e.g. Charpentier et al. 2002). As a result of both the spread of these examples in space and time and their occurring across different aspects of the reduction process we should always test a null hypothesis of convergent evolution. Whether certain technologies represent convergent evolution or not is currently the subject of considerable debate. For example, 'Nubian Levallois' technology has been argued to represent a very strong culture-historical signal (discussed in Groucutt 2020), yet numerous authors have suggested that convergent evolution probably best explains the distribution of Nubian Levallois technology (e.g. Groucutt et al. 2015a; Will et al. 2015; Clarkson et al. 2018; Eren et al. 2018).

While the reality of convergent evolution in the archaeological record is recognized by effectively all researchers, it should be pointed out that this introduces the notion of sliding scale in thinking about the importance of convergent evolution. I, for one, think there is a lot of patterning in the archaeological record and that this primarily reflects underlying population dynamics. Many dubious claims for particular models are based on single lithic types, and are easily dispensed with when one looks at the situation objectively. Convergent evolution seems to generally apply to individual elements of lithic assemblages, and so a rounded evaluation of different transmission processes needs to take a whole assemblage view. Just looking at a particular core reduction

method, or a particular retouched tool form is unlikely to give very clear solutions and are very vulnerable to convergent evolution (e.g. Groucutt 2020; Will and Mackay 2020).

Perhaps harder to deal with, perhaps, are putative instances of 'false negatives'. Tryon and Ranhorn (for example) point out that population connected by ancestry/cultural transmission, could actually go on to produce quite different lithics, because of factors such as different raw material variability. This difference could be mistaken for a lack of cultural transmission. Likewise, Stutz (2020) explores the possibility that contemporaneous technological variability—such as between different kinds of Upper Palaeolithic entity in the Levant—may not reflect the existence of different populations, but rather the same populations behaving different in different places due to ecological, demographic and mobility gradients. Stutz (2020) suggests that the same could apply with 'Bohunician' and 'Szeletian' assemblages in east-central Europe. While I do not doubt that regional patterns in the archaeological record mean *something*, it is really not clear what that something is. And it almost certainly not a one to one match with distinct and homogenous populations. Similarities between assemblages do not necessarily mean cultural transmission/shared histories, but then neither do differences necessarily mean a lack of cultural transmission/shared histories. I will discuss below ways in which we might get around this, but in short the key is surely multi-scale evaluations of what we mean by 'similar' and 'different', as well as detailed contextual understanding (e.g. chronology).

Population Thinking

We still do not know very clearly what variation in lithic technology or other aspects of the archaeological record mean in relation to populations. What, for instance, does the earlier heterogeneity of Levantine Epipaleolithic entities compared to a later homogenization with the 'Natufian' actually mean in terms of human population dynamics (Maher and Macdonald 2020)? And while on the Epipaleolithic example, what do different proportions of microlith forms tell us? This is how the record of the terminal Pleistocene of the area has been structured by modern archaeologists, but what is the actual social or behavioral meaning of making one microlith shape over another?

Several chapters offer insights into the nature and theorization of populations in early prehistory. Groucutt explores the simplistic equation of 'Nubian Levallois technology = Nubian Complex = the Nubians'. In such cases it seems clear from objective evaluations that even the lithic arguments do not stand up to scrutiny, let alone demographic/social interpretations of those claims. In other cases, however, there are clear patterns in the archaeological record, but what do these mean? What does it mean that MSA people in North Africa west of the Nile often made tanged/pedunculated tools, for tens and tens of thousands of years in the Late Pleistocene (Scerri 2017)? We currently have little grasp on the kinds of learning and social dynamics that could explain such phenomena.

To me, it seems clear that we need to move beyond outdated ad hoc 'techcomplexes' which lack coherent definition (e.g. some are defined by a core reduction method, some by a retouched tool form, some by the absence of certain features, etc.), let alone to use these as proxies for populations. The criticisms of 'named stone tool industries' have been presented in both mostly theoretical (Shea 2014; Scerri 2017) and in quantified 'practical' senses (Scerri et al. 2014). But what is to replace them? My inclination is that we have to more towards more continuous perspectives, such as the clouds of attributes states explored by Scerri and colleagues (2014; see also Mackay et al. 2014). How these relate to populations remains complicated, of course, but doing this at least moves towards an objective and data-centered approach, instead of collapsing huge complexity into simple words like 'Aterian'. And objectively characterizing the nature of lithic variability is something that we can do. In the context of the Middle Stone Age, for example, the 'Comparative Analysis of Middle Stone Age Artefacts' (CosMSAfrica) project has recently been launched in an effort to standardize methodologies across Africa (Will et al. 2019).

The final area when it comes to 'population thinking' reflects the need to think through the dynamics and implications of 'admixed populations'. Growing evidence indicates frequent admixture between distinct populations in the Pleistocene (although we must of course always be aware of how much this reflects the model parameters input by researchers). Stutz (2020) suggests that it was precisely an admixed *Homo sapiens*/Neanderthal population which made the Upper Paleolithic transition in Southwest Asia. This is another reminder that population dynamics, in their various forms and scales, are central to accounts of the Pleistocene.

Diversification

Most chapters in this volume concern stone tools, and ways of thinking about them. But that is not the exclusive focus of the book (e.g. Shennan 2020; Schmidt 2020). Reynolds (2020) highlights that understanding the European Upper Paleolithic record takes us beyond the realm of lithics alone, and into a world of personal ornaments, osseous technologies and so on. I think this is an important point, and we

have to avoid the lure of 'lithics for lithics' sake arguments. The strongest narratives, in my opinion, come from cross-cutting lithic information with other kinds of datasets.

Several chapters (e.g. Reynolds 2020; Shennan 2020) discuss genetic evidence. In the case of Europe, there is now enough ancient DNA to begin to outline some very interesting processes. It is fascinating to see that sometimes archaeology and genetics suggest congruent narratives, whereas other times they do not. For example, genetic evidence suggests major population turnover during the Late Upper Paleolithic, yet there is not a clear archaeological signal of this (Reynolds 2020). As ever greater numbers of ancient genomes are sequenced, there is a growing possibility to weave together biological and cultural narratives.

It is also important to think about the nature of processes which lie 'behind' variability in lithics. For example, it is very interesting to think about the notion of learning. If populations can be represented by particular forms of material culture, then leaning is the process by which these patterns are perpetuated. Interesting discussions have been published on learning, distinguishing emulation and imitation, and so on (e.g. Bentley 2018; Wilkins 2018). What kind of transmission mechanisms meant that similar forms, such as the bifacial technologies discussed by Shipton (2020), were transmitted for hundreds of thousands of years? The simple knapping experiment Shipton (2020) conducts highlights the potential of this kind of experiment to guide our thoughts here. The interesting hypothesis from Shipton's knapping study can be tested by larger experiments in the future. When it comes to learning we would do well to build on Tostevin's (2012) ideas on visibility—which focusses on the parts of lithic technological systems that require intimate social connection. Stutz (2020), for example, builds from this notion. There are diverse ways in which we can think about issues of learning and teaching. For example, Maher and Macdonald (2020) explore the notion of 'communities of practice' as a way to link assemblages with wider social structures and lifeways of Epipaleolithic human groups.

The Chapters

The chapters in this volume are organized in broadly chronological order, and cover a variety of topics, locations, and time periods. Here I will briefly summarize each of the chapters.

Shipton (2020) explores a topic of perennial interest, the Acheulean, characterized by iconic large cutting tools such as handaxes. The chapter explores whether the Acheulean represents repeated convergent evolution of similar forms, or rather if it spread from a single origin. Shipton does this in three ways. Firstly, he reports an anecdotal yet very interesting knapping experiment, to highlight that biface knapping is hard to invent, but easy to transmit. Secondly, he compares handaxe and cleaver elongation to highlight regional technological differences. Finally, he discusses the oldest ages for Acheulean sites in different regions, highlighting that current evidence supports an East African origin followed by a spread. Shipton's chapter highlights the important issue of understanding how East Asian bifaces are similar and different to the Acheulean assemblages west of the Movius line. He argues that they are in fact quite different, and that this represents an example of parallelism, both being invented from a common Oldowan base. Clearly, much remains to be done in understanding the world of the Acheulean, and Shipton indicates some of the ways in which we can go about improving our current knowledge.

McNabb (2020) explores the Clactonian, a technocomplex known from several sites in southeast England, dating to MIS 11 (i.e. ca. 400 ka). In contrast to both older and younger assemblages in the region, the Clactonian lacks large cutting tools such as handaxes, and is instead characterized by a simple core and flake technology. McNabb discuses different interpretations of the Clactonian, which makes an interesting case study of the meaning of archaeologically defined entities (technocomplexes, industries, phases, or whatever else one wishes to call them). As usual, McNabb does a good job of situating the research which led to the definition of the Clactonian in terms of its historical context. Changing views on the Clactonian have ranged from culture-historical perspectives to the very pragmatic (e.g. raw material factors). McNabb provides both a summary of the Clactonian in itself, but also a useful case study for the interconnected issues which this book is focused on. Future research will turn up surprises in poorly explored parts of the world, so it is important that lessons are learned from the areas where relatively large amounts of research have been conducted, such as northwest Europe.

Groucutt (2020) explores the example of the 'Nubian Complex'. Following recent findings of assemblages in southern Arabia characterized by 'Nubian Levallois' technology there has been some enthusiasm for the idea that this kind of technology is diagnostic of the 'Nubian Complex' which is seen as a culture-historical signal for the spread of a Northeast African population. Groucutt explores the history of the Nubian Complex, highlighting the problems and contradictions of the various definitions. In the end the evidence suggests that Nubian Levallois technology is found over such a huge temporal and spatial scale that the notion of the Nubian Complex is not helpful. Nubian Levallois technology is argued to provide a very interesting example of convergent evolution, probably repeatedly re-invented from a common background of 'normal' preferential Levallois technology.

Spinapolice (2020) explores the character and meaning of lithic variability in the Middle Stone Age of East Africa. As

a region containing some of the most famous sites in Pleistocene archaeology, various perspectives have been taken on this record: some have seen it as signaling the origin of our species, some have argued that East Africa contained key 'refugia', and so on. To consider such narratives it is important to have a clear understanding of the archaeological record of the area. Spinapolice (2020) provides a useful synthesis of the East African record, and highlights the complex and diverse ways in which lithic evidence can be related to social and demographic dynamics. This chapter reminds us of the importance of rooting archaeological accounts in terms of anthropology. Spinapolice introduces the idea of Significant Technological Units as a way to look at the Middle Stone Age record, and explores the example of bladelet production.

Will and Mackay (2020) present an evaluation of convergent evolution in Africa over the last 300,000 years. Their multi-scale approach offers refreshing insights, and highlights that convergence is both common and scale-dependent. Because of this, great care has to be taken in building narratives of population movement based on material culture (and here they build on their influential paper reporting Nubian Levallois technology in South Africa, thereby giving a strong example of convergent evolution [Will et al. 2015]). Nearly all lithic analysis would agree that convergent evolution *sometimes* occurred. Will and Mackay (2020) explore the important question: how frequent is convergence in lithic technology? To answer that requires clear definitions and strong theory, as well as an objective evaluation of the archaeological record. Will and Mackay (2020) argue that convergence is more common with certain technologies than others. Backed microliths, for example, seem to clearly show convergent origins (see also Clarkson et al. 2018). On the other hand, they argue that balanced perspectives are needed, and that clearly processes such as diffusion and migration did play a role in Stone Age Africa, and that we can see genuine examples of spatially and temporally specific technological features.

Douze and colleagues (2020) present a combined approach to understanding 'points' from Bushman Rockshelter in South Africa. Points have often been seen as a diagnostic feature of the Middle Stone Age, yet as Douze and colleagues discuss, definitions of what a point is have been highly variable. Given that points have been a key part of arguments for regionalization in the Middle Stone Age (e.g. Clark 1988), it is important to think about the character and diversity of point production. Douze and colleagues findings show the potential of combining detailed technological analyses with usewear and residue analyses to understand the archaeological record. Their results suggest that points at Bushman Rock Shelter were typically used for cutting and scraping tasks. Given the lack of high-resolution data it is difficult to distinguish regional trends in technologies such as point production. In South Africa, *relatively* intensively studied compared to the rest of the continent, arguments can be made about patterning in the archaeological record, but for vast areas of Africa so little is known that we currently have little idea on the extent to which 'point production ' repeatedly emerged by convergent evolution, as opposed to cultural transmission. Douze and colleagues (2020) show how modern 'techno-functional' analyses should be conducted. And even if one then wants to conduct highly detailed quantitative analyses of artefacts, this can be seen as an addition, not an alternative to this kind of approach.

Tryon and Ranhorn (2020) present an interesting case study of the role of raw material types in considerations of lithic technology, typology and metrics, and the way in which this can impact considerations of similarities and differences in the archaeological record which then feed into models of populations and behavior. They look at various East African assemblage from the Acheulean to the Holocene, and in particular emphasize the impact of the use of quartz by knappers. This is both in terms of the behavior of the knappers, and in terms of interpretation by contemporary lithic analysts. For knappers, certain raw materials impose constraints on the forms than can be produced. From the perspective of the lithic analyst, they argue that recent approaches such as those of Tostevin (2012), and the multivariate development of this approach (Scerri et al. 2014), cannot be easily applied to quartz dominated assemblages. For example, Tryon and Ranhorn (2020; see also Ranhorn 2017) describe difficulties such as reading scar patterns of quartz lithics from sites like Nasera. Likewise, the bipolar technology which is frequent in East Africa is not a significant element of the technological repertoire in areas studied Tostevin (2012) and Scerri et al. (2014) and therefore the methodologies that these authors developed. These are clearly issues that we need to take seriously and discuss if we are to develop reliable and replicable comparative frameworks. Finally, I think that Tryon and Ranhorn's (2020) chapter shows the benefits of thinking about themes through time instead of limiting oneself to a certain realm (the 'MSA' for example). That is something I would like to see more of in the future.

Stutz (2020) offers a novel perspective on a perennial topic of interest, the Middle to Upper Paleolithic transition. This transition has often been explained in terms of a 'human revolution' or, in some unclear way, the migration of *Homo sapiens* out of Africa. These narratives have never been particularly convincing, and Stutz (2020) outlines an alternative model where the transition reflected behavioral change in admixed *Homo sapiens*/Neanderthal populations. Stutz (2020) builds this perspective from considerations of niche construction and biocultural evolutionary dynamics. Instead of the earliest appearance of the Upper Paleolithic in

a region being a simple marker of the appearance of *Homo sapiens*, Stutz argues that the timeframe is better characterized as a long-term process unfolding as the result of admixture between Neanderthals and *Homo sapiens*. The Upper Palaeolithic emerges as a result of economic intensification within this new admixed population.

Reynolds (2020) considers the European Upper Paleolithic record, in both general terms and with a case study of Mid Upper Paleolithic Russia. This is a particularly pertinent area given the theme of this book, as it features numerous taxonomic units that are commonly associated with distinct populations (the Gravettians, the Solutreans, etc). However, as Reynolds (2020) argues, these taxonomic units are historically contingent and the theoretical bridge from these poorly defined entities to purported populations is very problematic. To move beyond the current situation Reynolds proposes an approach combining detailed understanding of the chronology of assemblages (which she refers to here as 'the warp') and detailed comparisons of material culture ('the weft'). By weaving these two parts together we can construct a reliable chronocultural framework. Of course, some of what Reynolds (2020) discusses has a specific relevance to the European Upper Paleolithic. However, the basic themes of the need for secure chrono-stratigraphy and for a bottom up rather than top down (i.e. techcomplex) approach apply to the entire archaeological record. Likewise, Reynolds (2020) discussion of radiocarbon dating is important, and deserves to be carefully considered.

Maher and Macdonald (2020) take us to the world of the Epipaleolithic Levant. This is typically studied in terms of being a precursor to agricultural communities, yet as Maher and Macdonald explore it also a fascinating period in its own right, without having to be seen as the precursor to something. Maher and Macdonald (2020) emphasize the importance of technology in understanding the Epipaleolitic of the Levant. They highlights the notion of 'communities of practice'. This situates lithic technology in terms of wider social practices and lifeways. Whether it is an approach one favors or not, Maher and Macdonald (2020) give a very clear description of a chaîne opératoire approach to lithic analysis. They remind us that the study of lithics should be aimed at trying to elucidate human lifeways and societies, not as an end in itself. They report the recovery of an incredible ca. three million lithics from the site of Kharaneh IV in eastern Jordan, of which they have analyzed about 10%. Given such vast numbers, we are reminded of the importance of stone tools in early human societies and the powerful information they can therefore surely provide.

Shott (2020) explores North American points. Points have been central to the construction of the North American archaeological record, yet as Shott explores, they can be seen from multiple perspectives. Shott (2020) explores questions such as how one point type changed to another and why did certain forms last for long periods. Such approaches emphasize the need for deep levels of theory, to transcend simplistic traditional views. What defines a 'point' (see also Douze et al. 2020)? To Shott, points in the Americas are mostly projectile tips, but beyond that embody high levels of variation. This variation offers a way to cut through the simplistic division of the record into 'cultures'. For Shott (2020) building a meaningful understanding of points takes various forms, from geometric morphometric analyses through to considerations of the appropriate time scales at which to consider points (i.e. beyond the scale of ethnographic observation).

O'Brien and Bentley (2020) explore the colonization of North America, with a particular focus on learning. They seek to explore novel ways of considering the notion of 'populations'. Several pre-Clovis assemblages are now increasingly accepted, but it is with Clovis that we see the first widespread human presence in the area. O'Brien and Bentley give a very clear and useful discussion of various issues relating to homology and analogy in material culture, and argue the best way to distinguish them is using cladistics. O'Brien and Bentley (2020) describe learning (particularly social learning) as the basis of cultural transmission. They explore the idea of fitness landscapes as applied to culture. Through these notions they explore variability in Clovis technologies—which they emphasize can be seen both in terms of overall shape, and in specific aspects such as scar patterns. They explore how as Clovis technology spread across America some aspects changed while others did not, which they interpret as reflecting different levels of learning/transmission.

Schmidt (2020) represents a very different approach to the others in this book, exploring heat treatment of stone used for stone tool production, rather than details of lithic technology as most chapters address. Heat treatment has been celebrated as an early example of complex behavior in humans, yet it has been debated how exactly humans were heating the rocks and the implications these behaviors have for planning, cognition, etc. Schmidt (2020) compares different examples of heat treatment across time and space, from the Middle Stone Age of South Africa to the Paleo-Indian period of North America. He explores how the specifics of heat treatment varied in these different settings—with the stone sometimes being buried, sometimes not, and the temperature of the fire varying. Schmidt (2020) argues that this behavioral diversity indicates repeated convergent evolution of heat treatment in different settings. While the study of early prehistory remains focused on stone tool reduction technology, Schmidt (2020) reminds us that finding additional lines of research on early human behavior offers very exciting avenues for future research. As great as lithics are, it is incumbent on us to continually seek to develop innovative new techniques to study the past.

Finally, Shennan (2020) explores the themes of style, function and cultural transmission. Shennan (2020) summarizes some of the seminal debates in archaeology, such as the Bordes-Binford debate, and brings us to the major contemporary topics of research in cultural evolutionary studies. Shennan (2020) outlines useful ways forward. These include the formation of clear and testable models, for example testing a null hypothesis of 'isolation by distance' can be a very useful approach (see also Scerri et al. 2014, 2018). Shennan and colleagues (2015) have previously demonstrated the utility of this approach in relation to Neolithic pottery and ornaments. Shennan (2020) outlines ways in which hypotheses on prehistoric cultural evolution and relationships can be tested using ancient DNA evidence.

Conclusion

My main aim with this book is to provoke questions, while offering few answers. The issues involved are too deep and fundamental for simple and immediate solutions. It seems evident that the definitions of many of the terms we commonly use and the ways we employ them—such as populations and cultures—are at best poorly defined and theorized, and at worst positively confusing and unhelpful. Without developing the crucial 'scaffolding' that such concepts should facilitate, the ever-growing mass of data is going to lack secure anchoring.

Things used to be so simple in archaeology, when it could be declared that "typological similarity is an indicator of cultural relatedness" (Willey 1953, p. 363). Over the following decades the naivety of such views became clear (e.g. Binford 1968; Clarke 1968). Yet, in my opinion, archaeology is still struggling to deal with convergent evolution. And, in their different ways, both 'evolutionary archaeology' and 'chaîne opératoire' approaches (to rather sloppily characterize two relative research poles) have struggled with the recognition and consideration of convergent evolution. Archaeologists have tended to argue, in effect, that the more similar things are then the less likely convergent evolution is (e.g. Kroeber 1931; Clarke 1968). I do not think this perspective has worked, and we now need to develop better ways of thinking about convergent evolution. Convergent evolution does not just matter in terms of understanding how people made different forms of material culture, but because of the wider implications in terms of recognizing social structures and populations. Casting light on the demography of early humans is now crucial in advancing our understanding of human evolution (e.g. Scerri et al. 2018), and a failure to develop ways to recognize convergent evolution means building a time-bomb into the use of cultural data.

In my opinion, strong arguments on convergent evolution will come from threefold analyses of archaeological data (such as lithics) using sophisticated and objective techniques to explore patterns of similarity and difference in multiple independent areas of material culture (e.g. core reduction methods, forms of retouched tools, etc.) and ideally include both lithic and non-lithic data, experimental studies (such as knapping experiments), and chronometric dating of archaeological sites. Various combinations of these three elements can be found in the chapters of this book. Fire can be described in terms of a triangle (heat, fuel, oxygen). If any one side is removed or dampened, the fire goes out. Likewise, with studies of human prehistory, archaeological data, experimental studies and chronometric dating stand in symbiotic relationship and neglecting one means an entire argument can collapse.

In my opinion, methodological plurality is a good thing. Methods should be used if they help to answer questions, not just because they were used by earlier researchers. Surely progress will come from combining the 'static' but objective analysis of objects with the 'dynamic' but sometimes rather abstract study of processes. In terms of higher-level theoretical frameworks, we need approaches which can clarify both gradual processes of change (or even stasis) and sudden transitions and inventions. We need a body of methods and theory which are unique to archaeology (within the wider field of paleoanthropology), and not simply attempts at wholesale import of methods from other areas (e.g. biology, ethnography). We should also try and recognize our biases, and move beyond a focus on individual know how and arguments from authority, towards more objective and quantified perspectives (see e.g. O'Brien et al. 2018b, p. 16). Likewise, we should emphasize the study of questions, not just using a new method because it is new. The methodological and theoretical pitfalls are numerous, but if we can work through these issues we can make material culture relevant to understanding some of the biggest questions in the study of human evolution and prehistory. Building a solid understanding of convergent evolution will firmly embed our subject as a science, while failure to do so will mean that we drift into storytelling while the scientific research is done by others.

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