Chapter 13
Steps Towards Operationalising an Evolutionary Archaeological Definition of Culture

Felix Riede

Introduction

There is considerable debate among anthropologists and archaeologists about the ontological status of human "culture". A plethora of definitions have been offered (Kroeber and Kluckhohn 1978; Kuper 1999), the vast bulk of which are anchored in ethnographic accounts or foreground cognitive dimensions of human experience. Hence, they are of limited utility to archaeologists who, by and large, have to contend with a patchy and discontinuous record that consists exclusively of more or less durable material culture. Although of limited analytical utility to archaeologists, many definitions of culture nonetheless recognise that the social transmission of information is at its core (for a recent review of the North American literature, see Lyman 2008). Pitt Rivers (1875, 298), for instance, noted that "hereditary transmission" of cultural traits underpins our ability to recognise series of cultural transformations. These observations were later formalised in the typological method (Montelius 1903) and subsequent seriation approaches (O'Brien and Lyman 1999; Riede 2006b, 2010a).

In this paper, I argue that an alignment of "culture" with processes of information transmission allows the development of a specifically archaeological definition of culture under the umbrella of Darwinian theory. Such an approach rests on the rejection of typological concepts of culture, which remain widespread in archaeology. Instead, it is argued, culture may be understood as a materialist, population-level phenomenon that is generated through the actions of individuals and that it takes archaeological shape through the consistent socially learnt repetition of such actions across generations. In a historical perspective, this approach lends itself to tree-like exploratory models – cultural phylogenetics – and this may aid in not only classifying a given set of archaeological remains into culture-like groupings, but also in answering long-standing questions about processes of change in material

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culture, action and behaviour. I present a brief case study from the Southern Scandinavian Late Glacial illustrating how such a specifically evolutionary archaeological method of defining cultures can be operationalised.

Information Transmission and Material Culture Evolution

The transmission of information is at the core of Darwinian models of evolution (Jablonka and Lamb 2006). First formalised with respect to genetic information transmission, there is now a widespread recognition that salient information transmission covers a much greater number of domains, such as the epigenetic, the social and behavioural, as well as the ecological (Jablonka and Lamb 2005; Nielsen 2007; Odling-Smee 2007; Odling-Smee et al. 2003; Wells et al. 2006). Noted already by Lewontin (1970) a long time ago, Jablonka and Lamb (2006, 237) reiterate that Darwinian evolution can emerge in any information transmitting system because…

> … the transmission of information between generations, whether through reproduction or through communication, requires that a receiver interprets (or processes) an informational input from a sender who was previously a receiver. When the processing by the receiver leads to the reconstruction of the same or a slightly modified organization-state as that in the sender, and when variations in the sender's state lead to similar variations in the receiver, we can talk about the hereditary transmission of information. This typically occurs through reproduction, but it can also occur through communication if communication leads to a trait of one individual being reconstructed in another. Clearly, if the hereditary transmission of information is seen in this way, there is no need to assume that all hereditary variations and all evolution depend on DNA changes.

The archaeologists Eerkens and Lipo (2007, 246) underline that "it is more productive to conceive of a general case in which genetics, culture, language, and the like are simply versions of generic inheritance systems, structured means in which information is passed between sources and destinations. These systems differ greatly in their implementation, dynamics, and degree of fidelity…but this is irrelevant to their information-theoretic structure". In sum, when the transmission of information between generations – by whatever means – displays the properties of trait *variation* between units, *heritability* and *differential representation* of these traits from one generation to another, some form of Darwinian evolution is the result. Note that in such formulations of Darwinian evolution, crude selection and survival only play minor roles. The agents creating the material culture variation act purposefully and intentionally. They are knowledgeable, yet they are not omniscient (Mesoudi 2008) and the picture of cultural evolution invoked here is demonstrably not the kind of evolution caricatured by post-processual theorists (e.g. Shanks and Tilley 1993).

That Darwinian theory holds some promise for understanding long-term material culture change was recognised early on by pioneering scholars, such as the Swedish antiquarian Oscar Montelius. Although it took some time for Darwin's ideas to become widely disseminated in Scandinavia (Kjærgaard and Gregersen 2006), references to his works become more common in archaeological texts shortly after translated works first become available. In the early 1870s, the Swedish scholar Hans Hildebrandt (1873, 17) stated that "if any science at present needs its Darwin, it is comparative archaeology".

Recognising the evident similarities in the palaeontological and archaeological records, and the challenges faced by workers in both fields, he went on to draw explicit analogies between archaeology and palaeontology (e.g. Hildebrandt 1880). Oscar Montelius further elaborated this point by making the case for the similarities between cultures in an archaeological and species in a palaeontological sense (Montelius 1884, 1899). Beyond this basic insight, he (Montelius 1903, 20) argued that

> It is in actual fact rather amazing that Man in his labours has been and is subject to the very same laws of evolution. Is human freedom indeed so limited as to deny him the creation of any desired form? Are we forced to go, step by step, from one form to the next, be they ever so similar? Prior to studying these circumstances in depth, one can be tempted to answer such question with «no». However, since one has investigated human labours rather more closely, one finds that clearly, the answer has to be «yes». This evolution can be slow or fast, but at all times Man, in his creation of new forms, needs to conform to the very same principles that hold sway over the rest of nature.

Montelius clearly recognised that the evolution of culture was historically constrained, that the creation of new forms was contingent on their predecessors, and that the transmission of information is vital in shaping material culture expressions. His student Nils Åberg (1929, 508) reiterated that "typology is the application of Darwinism to the products of human labour". However, the notion that cultures are analogous (as natural or analytical units) to species as they were thought of in the late nineteenth and early twentieth centuries is fundamentally flawed, precisely because both entities were defined typologically. The species concept in biology is still controversial (e.g. Ereshefsky 1992; Mayr 1957; Rieppel 2007), but the essentialism of typology has long been abandoned for "population thinking" (Ghiselin 1974; Hull 1965; Mayr 1959). This epistemological revolution came about at a time when archaeologists had roundly rejected the application of Darwinism to human works (e.g. Brew 1943) and had instead turned to ecologically and sociologically inspired approaches (Riede 2006b, 2010a; Trigger 1989), despite the fact that Mayr brought this issue to the attention of anthropologists at the time (see Mayr 1959). As a consequence, many archaeologists employ types for building diachronic sequences and for making arguments about change over time, something for which such entities are profoundly ill-suited (Lyman and O'Brien 2003, 2004; O'Brien and Lyman 2000). From the adoption of population thinking flows a focus on *variation* and the need to use quantitative techniques (Mayr 1976, 27–8):

> The assumptions of population thinking are diametrically opposed to those of the typologist. The populationist stresses the uniqueness of everything in the organic world. What is true for the human species, that no two individuals are alike, is equally true for all other species of animals and plants… All organisms and organic phenomena are composed of unique features and can be described collectively only in statistical terms. Individuals, or any kind of organic entities, form populations of which we can determine the arithmetic mean and the statistics of variation. Averages are merely statistical abstractions; only the individuals of which the populations are composed have any reality. The ultimate conclusions of the population thinker and the typologist are precisely the opposite. For the typologist, the type (eidos) is real and the variation an illusion, while for the populationist the type (average) is an abstraction and only the variation is real. No two ways of looking at nature could be more different.

Eerkens and Lipo (2005, 2007) and Eerkens and Bettinger (2008) have similarly argued that variation in material culture should be the focus of archaeological enquiry, at least in so far as it is concerned with the social transmission of information.

Population thinking alone, however, cannot lead to a readily operationalised definition of culture in an archaeological sense. While helpful to ethnographers working with contemporary populations (Bloch 2005; Sperber 1996), and indeed some anthropologists pursuing an evolutionary approach (Mace and Holden 2005), these definitions of culture are predicated on having comprehensive linguistic information. Cultures, in this view, are socio-linguistic entities and mutual intelligibility is understood as a proxy measure of interaction akin to Mayr's (1957, 2000) interbreeding criterion (Fig. 13.1). For archaeologists lacking linguistic information,

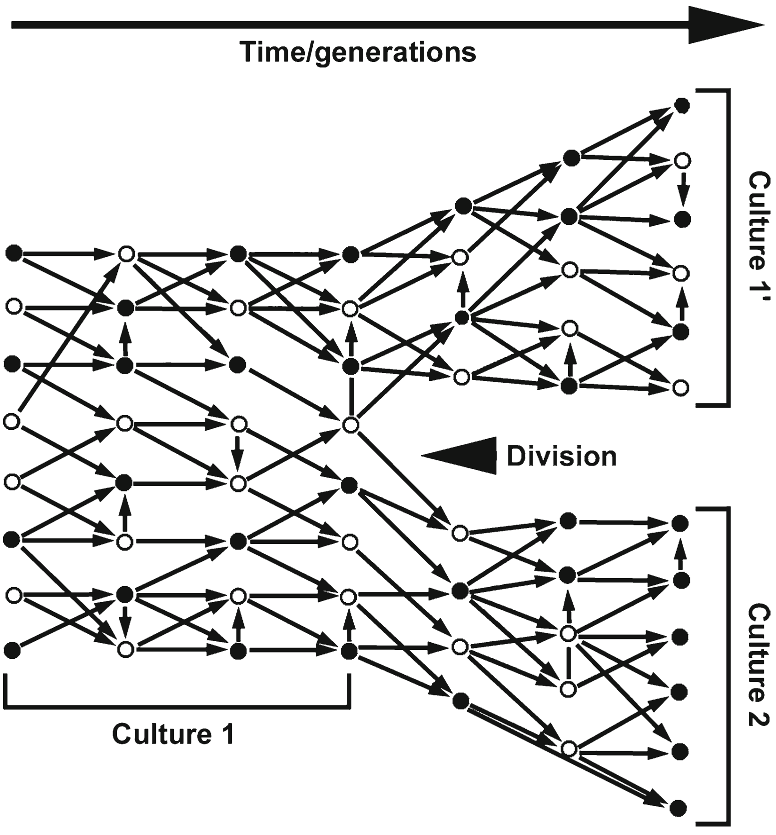

Fig. 13.1 An archaeological culture (Culture 1) as a heterogeneous population of teachers/learners (*open circle* and *filled circle*) and their intellectual and/or artefactual sub-lineages. The various modes of cultural transmission (vertical, oblique and horizontal; see MacDonald 1998) produce complex patterns of expression. Over time/generations, when the horizontal transmission between two segments of the ancestral population diminishes, empirically recognisable new cultures arise (Cultures 1′ and 2). Which particular mode of transmission dominates at a given time is an empirical question (Bellwood 1996). Note that what is not shown here is that in each generation some individuals are likely to leave no cultural descendant, terminating a particular sub-lineage. This figure is redrawn from Hennig (1966)

however, such a formulation is problematic. Palaeobiologists who cannot observe interbreeding directly face similar difficulties and have argued that a phylogenetic species concept may be more suitable to examining long-term changes in the historical relatedness and changes in adaptation in the organic world (e.g. Mishler and Theriot 1999; Nixon and Wheeler 1990; Wheeler and Platnick 1999). These species, however, are not ontologically equivalent to living species, just as an archaeological culture or techno-complex cannot be compared to cultural groups observed ethnographically. In order to avoid confusion, therefore, the culture = species notion should be rejected. Where does this leave us?

It is important to remember that species in palaeontology are merely one kind of taxonomic unit (Lee 2003). Phylogenetic species then are one of the operational taxonomic units (OTUs) of palaeobiology, and it has been suggested (Foley 1987), most recently by Gamble et al. (2005), that similar units should be used in archaeological enquiry. The use of archaeological taxonomic units (ATUs) incorporates the key epistemological insights of the rejection of essentialism and avoids the terminological confusion surrounding the term “culture”; they are the “cultural counterpart to the operational taxonomic unit (OTU) of biology and evolutionary science” (Gamble et al. 2005, 195). In contrast to most definitions of “culture”, the ATU concept offers archaeologists a pragmatic avenue for constructing appropriate units for cultural phylogenetics, because as O’Hara (1997, 323) has suggested “tree thinking” complements the population perspective by providing an explicit historic dimension (O’Hara 1997, 324–5, my emphasis):

> Tree thinking is simply the phylogenetic counterpart to population thinking, and like population thinking it has brought a more completely evolutionary perspective to systematics… Tree thinking, in contrast to group thinking, considers species in a phylogenetic context, not as independent replicates but as parts of a single phylogenetic tree. If we seek to understand common causes acting in evolution then the replicates we need to examine are not species, but the evolutionary events that are of interest in a particular study, and this can only be done by plotting those events on a tree… Although tree thinking…is an aspect of systematic biology, the idea of tree thinking isn’t necessarily tied to living things – all it requires is descent and inheritance.

A great number of recent studies have advanced the use of tree-building approaches in anthropology and archaeology (Lipo et al. 2006; Mace et al. 2005; O’Brien 2008; O’Brien et al. 2003). Here, I query one of these approaches using a case study from the Southern Scandinavian Late Glacial. In particular, the resulting phylogenetic diagrams will be explored as tools for defining archaeological cultures.

Defining Archaeological Taxonomic Units

Although Gamble and colleagues have reopened the discussion on taxonomic units in archaeological analyses, they fail to provide an adequate methodology for actually constructing such units. Taxonomies remain inert classification exercises unless they are placed into an explicitly evolutionary framework (see Riede 2009b; Fig. 13.2). The subjects of evolutionary archaeological analysis

	Equivalent	Examples from Gamble et al. (2005) > *this study*
ATU1	Period	Palaeolithic, Mesolithic, > *Late Upper Palaeolithic*
	Sub-period	Early Mesolithic, > *Terminal Palaeolithic*
ATU2	Techno-complex / Culture	Aurgignacian, > *Arch-Backed Piece Complex*
	Culture / Industry	Upper Magdalenian, > *Hamburgian, Bromme*
	Industry / assemblage	Magdalenian IV, > *Havelte phase*
ATU3	Artefacts / type fossils	Navettes, Mouilah points, > *Zinken, Bromme points, Wehlen scraper*
	Attribute	Scalar retouch, truncation, > *tang-thickness / orientation, tip retouch*

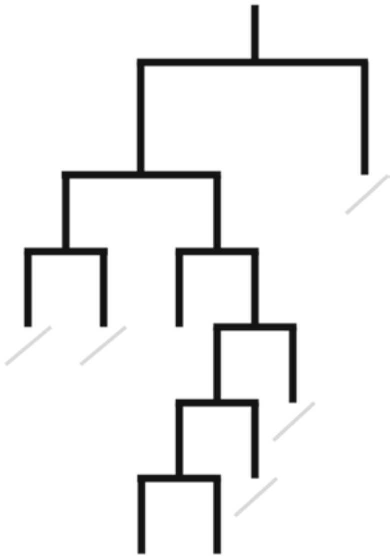

Fig. 13.2 *Left*, the division of archaeological taxonomic units for the North European Late Glacial suggested by Gamble and colleagues. The text in italics are examples from this study. *Right*, a schematic representation of how these units may map onto to a phylogenetic branching diagram. Such diagrams must be generated, and read, from bottom to top beginning with the smallest units distinguishable by a shared history of social information transmission

are the "learning lineages" (Harmon et al. 2006, 209) of craft production, manifest in their consistent and repeated material expressions.

By virtue of their biological endowment, humans are strongly predisposed towards both learning (Fragaszy and Perry 2003; Laland 2004; Reader and Laland 2003; Shennan and Steele 1999; Tomasello et al. 1993) as well as teaching (Csibra and Gergely 2011; Tehrani and Riede 2008; Thornton and Raihani 2008). Contexts of scaffolded learning and indeed of active teaching can, at least on occasion, be identified in the archaeological record (see Bamforth and Finlay 2008). Although other methods for identifying the appropriate units of cultural transmission (Pocklington 2006; Pocklington and Best 1997) have been put forward, Apel (2008), Apel and Darmark (2007), Riede (2006a, 2008b) and Tehrani and Riede (2008) have suggested that detailed technological analyses, following the *chaîne opératoire* approach, can be used to identify those elements of material culture that are consistently passed on from generation to generation, at a level suitable for archaeological enquiry. Similarities in material culture are so generated through the historical relatedness of their makers and their placement within communities of learners/teachers that persist over archaeological time. On the level of the population of learners, such traits – as proxies for the knowledge, skill and know-how – can be tracked in space and time. Specifically for the Late Glacial, it can be demonstrated at several locales that teaching played an important role in the transmission of craft skills (Bodu et al. 1990; Pigeot 1990) taking place at flint-knapping "schools" and workshops (Fischer 1988, 1989b, 1990). Such traits are decidedly not memes (Dawkins 1976) or cultural viruses (Brodie 1996; Cullen 1996); these cannot be identified archaeologically (Lake 1998) if indeed they can be identified or exist at all (Aunger 2006; Bloch 2000; Boyd and Richerson 2000; Sperber 2000). Either way, a replicator akin to genes is not a necessary condition for cultural evolution to follow Darwinian principles (Henrich and Boyd 2002; Henrich et al. 2008) and a focus on knowledge and its material expression in durable craft items offers an empirically more solid, and at least for archaeologists much more useful, starting point. Placing knowledge and know-how firmly at the centre of an evolutionary approach to culture further highlights the conceptual ground that this approach shares with other archaeological paradigms, especially agentive ones (Riede 2005; VanPool 2008; VanPool and VanPool 2003). Although traditionally seen as theoretically conflicting, Apel (2008: 95) has recently noted that, encouragingly, "this division of interest has diminished as researchers use the operational chain approach in studies of evolutionary aspects of artefact continuity and change". As pointed out repeatedly by Shennan (1989, 2004a, b), these approaches are in fact complimentary, with the evolutionary framework, providing a diachronic perspective on individual action.

Actions are executed by individuals (Dobres 2000). In order to construct ATUs grounded in empirical values, we must therefore begin with individual artefacts. The approach adopted here largely parallels those by O'Brien and colleagues (Darwent and O'Brien 2006; O'Brien et al. 2001, 2002) and Buchanan and Collard (2007, 2008a, b), except that it foregrounds the relation of technological action to the attributes used in the analysis. I focus on lithic projectile points from the Southern Scandinavian Late Glacial. Projectile points in general are often sensitive culture-historical markers (Beck 1998) and the Southern Scandinavian data-set is no exception (Fig. 13.3): "There are several grand changes in lithic projectile points that provide horizon markers for all of northwestern Europe" (Price 1991, 198). On the basis of these changes, the culture-historical sequence consists of the Hamburgian culture ("Classic" and Havelte facies), and the Federmesser groups (FMG), followed by the Bromme and Ahrensburgian cultures (see Eriksen 2002; Terberger 2006). Yet, as Fischer (1993, 52) points out "knowledge of the geographical and chronological range of the four groups is as yet very limited. As a result, any attempt to assess their inter-relationship must remain preliminary". While some workers (e.g. Madsen 1996) have suggested that repeated episodes of colonisation or *landnam* may have shaped this picture, others see the process as one of gradual, continuous and autochthonous adaptation of local human groups to slowly ameliorating climatic conditions (e.g. Fischer 1989a, 1991). However, recent advances in environmental science have led to a major refinement of traditional time-averaged climatic models based largely on relatively low-resolution pollen analyses (Björck et al. 1998; Blockley et al. 2006; Burroughs 2005; Eriksen 2002). In particular, recent revisions of the dating for some of these techno-complexes (Grimm and Weber 2008) and the growing recognition that the Laacher See volcanic eruption, dated to c. 13,000 BP (Baales et al. 2002; Blockley et al. 2008), had a major impact on the culture-historical development in the area (Riede 2007a, 2008a)

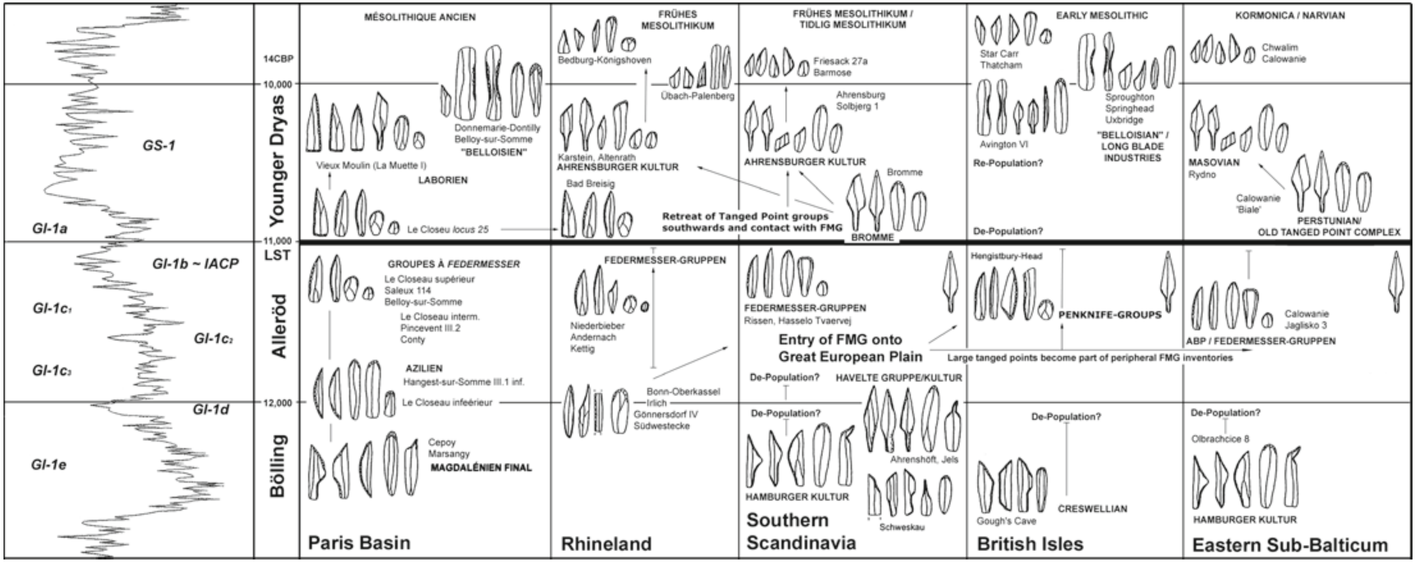

Fig. 13.3 A culture-historical scheme for some regions in Northern Europe, juxtaposed to the high-resolution δO^{18} temperature proxy record of the GISP2 ice-core. The scheme is originally based on Baales (2002), but modified in light of recent work (see text and Riede 2007b)

make a reassessment of the Southern Scandinavian Late Glacial both pressing and timely (see Gramsch 2004). Despite over 150 years of archaeological research in Southern Scandinavia (Jensen 1982; Klindt-Jensen 1975), we remain "stymied…by our lack of basic taxonomic knowledge of the parts that make up the things we identify as societies" (Pocklington 2006, 30). It is this lack of taxonomic clarity then, rather than a particularly patchy database, which makes unravelling the processes that have shaped the Late Glacial archaeological record in this region so difficult.

For this study, a database of 607 projectile points was collated. Each specimen was examined for a suite of 23 qualitative/technological and quantitative/metric traits (Fig. 13.4 and Appendix 13.1). Using exploratory data analysis (e.g. Tukey 1977), an appropriate coding schemes for each character was devised. Interestingly, this approach has recently been shown to not only facilitate a reasonably faithful (yet strictly quantitative) discrimination of artefact classes, but that these classe can match onto meaningful emic definitions (Abramov et al. 2006; see also Begossi et al. 2008 for a discussion of how biological folk taxonomies correspond to those derived using biological scientific principles). In an initial analysis, the NETWORK

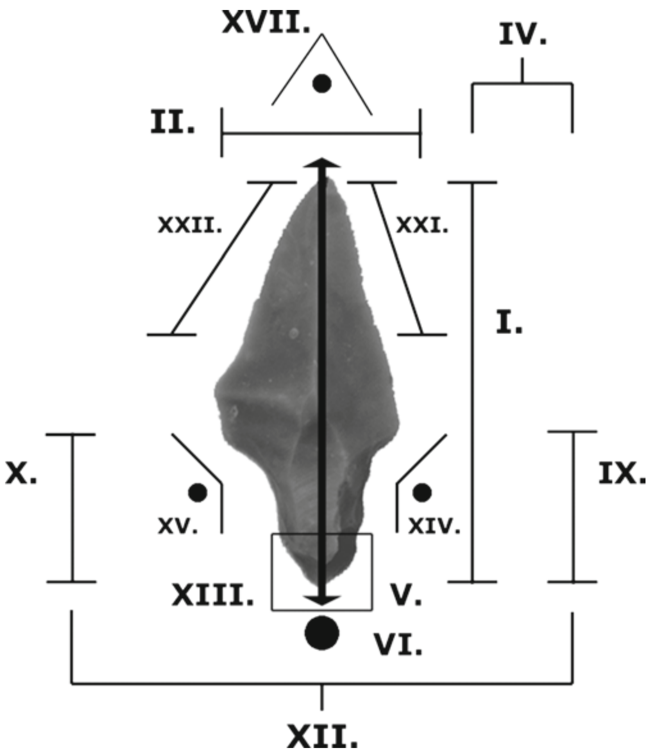

Fig. 13.4 An example of the lithic armatures measured for this study. Photo by the author with permission of the National Museum of Denmark, Copenhagen. All attributes measured and those used in the final phylogeny-building exercise are listed in Appendix 13.1

software (www.fluxus-engineering.com) was used to construct a phylogenetic network, based on the entire database. Phylogenetic networks are powerful new tools in phylogenetic analysis, specifically designed for dealing with large amounts of data, and for investigating the reticulating or horizontal transfer of genetic information (Bandelt et al. 1999; Morrison 2005). Recent studies in cultural and linguistic phylogenetics have applied these (Forster and Toth 2003; Nakhleh et al. 2003, 2005; Riede 2008b) and similar (Bryant et al. 2005; Lipo 2006) methods to counteract the long-standing criticism that reticulation and blending in cultural evolution obscure the historic/phylogenetic signal in cultural data beyond retrieval (Brew 1943; Kroeber 1917; Moore 1994; Terrell 1988). The results presented in Fig. 13.5 show that although the network is no doubt complex, it does show significant tree-like structure. Moreover, the phylogenetic analysis successfully recovers the broad, traditional typological categorisations, but provides an explicit hypothesis of how these are related. The most salient feature of the network graph is the different structures found within the four techno-complexes: the more clustered patterns in the Bromme culture, for instance, imply fewer strictures on flint knapping, its teaching

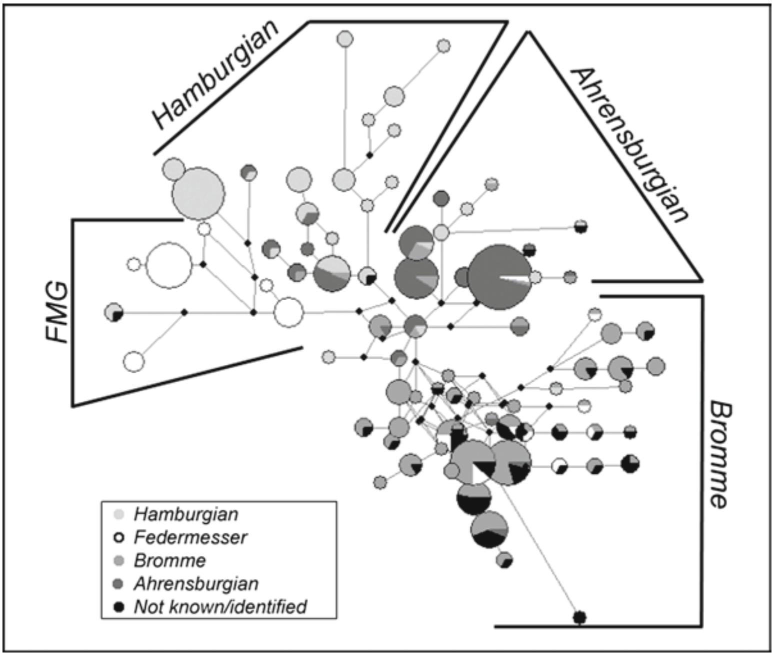

Fig. 13.5 A phylogenetic network of Late Glacial projectile points from Southern Scandinavia. Node size is proportional to the number of actual artefacts that fall into it and each node is shade-coded by its typological composition. The typological assessment of the excavator or curator is followed in this. Note the contrast between, for instance, the Bromme cluster with many smaller but highly connected nodes and the Hamburgian cluster showing a more linear arrangement with, on average, larger nodes. Guidelines for the interpretation of phylogenetic network graphs are given by Bandelt et al. (1995, 1999)

and execution than, for instance, in the Hamburgian. This notion is supported by broader technological analyses that view Bromme technology as relatively "straightforward" (Madsen 1992, 128), "wasteful" (Fischer 1991, 116) and "simplified" (Barton 1992, 192), while the Hamburgian flint technology as highly elaborate, "a more complex technology, perfectly fitted to having scarcer and perhaps more distant and varied lithic resources" (Madsen 1992, p. 128). This complexity is somewhat paradoxical in light of the ready abundance of high-quality flint in Southern Scandinavia (Madsen 1993), but can be explained in term if historical inertia – a reflection of the Magdalenian ancestry of Hamburgian groups (see Burdukiewicz and Schmider 2000; Schmider 1982). Alternatively, the linear arrangement of Hamburgian clusters may indicate successive bottlenecking in small populations under fairly tight regulation of craft production.

Incorporating the entire range of technological variability in the dataset used here is conceptually attractive, but it distracts from the overall goal of defining ATUs or cultures. Although individual idiosyncrasies are clearly critical for cultural evolutionary processes by generating variation on which selective processes can act, it is repeated behavioural patterns and consistent trans-generational teaching and learning that are of interest here (see also O'Brien et al. 2002). The NETWORK software provides useful statistical output which allows a stepwise exclusion of characters from the analysis in order to refine the phylogenetic signal (see Riede 2007b for further details). The exclusion of highly variable characters and the focus of stable "constellations of knowledge" (Keller and Keller 1996) reduce the dataset to a matrix of 16 ATUs, each defined by 12 characters (Table 13.1).

For the analysis of such smaller datasets, a number of techniques are available (Felsenstein 2004; Hall 2004). Many archaeologists have used tree-building methods to investigate both variability in stone artefacts in general (Cziesla 1998; Kind 1992) as well as specifically European Late Glacial cultural differentiation (e.g. Burdukiewicz 1986; Burdukiewicz and Schmider 2000), but invariably these were the so-called phenetic approaches, which are inadequate for distinguishing historical relatedness (Brooks and McLennan 1994). Both parsimony-based as well as maximum likelihood (ML) approaches can be used to generate evolutionary trees, and both methods can be used in the context of defining archaeological cultures phylogenetically. Here, I chose Bayesian phylogenetics because it provides a statistically robust way of constructing phylogenies for use in comparative analyses (Mace and Holden 2005; Mace and Pagel 1994). Bayesian statistics has already been introduced to archaeology in the area of radiocarbon calibration (e.g. Bronk Ramsey 2009; Buck 2001) and functional artefact classification (Dellaportas 1998). They offer a means of incorporating uncertainty and prior information about the data into its analysis. Bayesian phylogenetics is ideally suited for tackling what has become known as "Galton's Problem" (Naroll 1961), first raised by Francis Galton in response to a cross-cultural analysis of marriage patterns by Edward B. Tylor. Galton objected that "some of the occurrences might result from transmission from a common source, so that a single character might be counted several times from its mere duplicates", in other words that historically related units of analysis are not statistically independent because they may be derived from a common ancestor (see Tylor 1889,

Table 13.1 Characters and character states used in the Bayesian tree-building exercise

Character	Character state	Character	Character state
I. Maximum length	0. ≤45 mm	VII. Tang retouch	0. Opposing
	1. 45–68 mm		1. None
	2. >68 mm		2. Same side
II. Maximum width	0. <19 mm	VIII. Tang symmetry	0. >2.5
	1. ≥19 mm		1. 1.5–2.5
			2. 1.0–1.4
III. Maximum thickness	0. <5 mm	IX. Tip retouch	0. None
	1. ≥5 mm		1. Unilateral
			2. Bilateral
IV. Size[a]	0. <39	X. Combined tang/body ratio[b]	0. <23
	1. 39–58		1. 23–42
	2. 59–166		2. >42
	3. >166		
V. Tang/body ratio[c]	0. Unilateral retouch	XI. Retouch extent ratio[d]	0. 4–18
	1. No tang		1. 19–40
	2. <2.0		2. >40
	3. ≥2.0		
VI. Percussion bulb morphology	0. Faint bulb	XII. Tang retouch symmetry	0. ≤1.4
	1. Pronounced bulb		1. No tang
	2. Distinct bulb with scarring		2. >1.4

[a]Size = length × width × thickness
[b]For this ratio maximum length is divided by the tang/body ratio of the specimen
[c]Tang/body ratio is the ratio between maximum length and the lowest common tang measurement of a specimen (i.e. however far retouch extends on both sides of the specimen)
[d]This is calculated by adding together the total retouch extent of a given specimen and dividing this by length multiplied with width

272). All comparative analyses, be it of cultural or biological data, are plagued by this methodological challenge and although a number of non-phylogenetic solutions have been suggested (e.g. Denton 2007; Hull 1998), the use of phylogenies as hypotheses of historical relatedness among the units under consideration allows valid statistical procedures to be developed (Harvey and Pagel 1991; Mace and Pagel 1994; Pagel 1992). Contemporary comparative methods offer an arsenal of analytical techniques that take account of Galton's objection. They are "one of biology's most enduring sets of techniques for investigating evolution and adaptation" (Pagel and Meade 2005, 235). They can also be used to examine a variety to cultural processes, and have seen increasing application by phylogenetically minded anthropologists (Mace and Holden 2005; Mace and Pagel 1997, 1994; Mace and Sellen 1997).

The results of this analysis are presented in Fig. 13.6. Not surprisingly, some of the traditional typologically defined groupings are evident. However, it is noteworthy that statistical support for the Hamburgian clades is low and that FMG and Hamburgian (esp. Havelte Group) taxa are often grouped together. In light of recent dating evidence (Grimm and Weber 2008), this can perhaps be interpreted as an

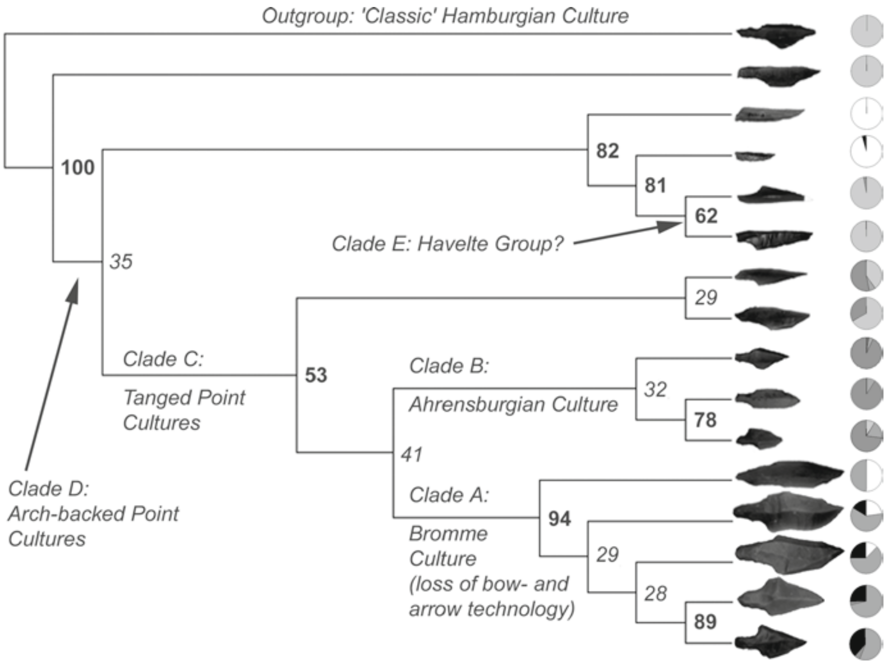

Fig. 13.6 The consensus tree based on a sample of 100 maximum likelihood trees produced using the Markov Chain Monte Carlo (MCMC) methods implemented in *BayesPhylogenies* (Pagel and Meade 2004). The model of evolution used is a simple multistate model (KSTATES), where the rates of gain and loss of the traits are presumed to be equal. A total of 10,000,000 iterations were run and the tree universe sampled at every 40,000th iteration to ensure statistical independence of each sample. This tree is rooted with the taxon that contains dates from the site with the oldest radiocarbon date in the region (Ahrenshöft: see Clausen 1998), belonging to the ("Classic" Hamburgian culture). The numbers along the branches are the posterior branch support. Note that support for some clades is rather low. This may indicate the degree to which horizontal transmission has shaped these taxa and their position. Only coherent clades with high branch support, for instance clade A (Bromme Culture), should be used to define archaeological "cultures". As in Fig. 13.5 the pie charts behind each taxon show the typological composition of each taxon. The mixed composition of some taxa may be due to mis-classification of specimens, in particular those derived from older excavations. The difficulty of distinguishing morphologically and technologically between some Hamburgian and Ahrensburgian artefacts, for instance, has created some confusion about the relatedness of these groups. Before radiocarbon dates became available, the Ahrensburgian was commonly seen as a direct descendant of the Hamburgian (e.g. Bordes 1968), in part because both groups practised specialised reindeer hunting economies, but despite the fact that there are salient differences in their technology, settlement pattern and demography (Riede 2007c, 2009a). Note also the occurrence of large tanged points assigned to FMG on contextual grounds. These make up parts of the ancestral Bromme taxa and indicate that the origin of this clade or culture must be sought in the Federmesser groups of the middle Allerød (Riede 2007a, 2008a)

indication of significant interactions between these northern and southern groups, respectively. The Bromme clade is both robust and highly diverse. This clade was the result of the isolation of northern groups following the eruption of the Laacher See volcano and the subsequent demographically mediated loss of bow-and-arrow technology as well as more complex stone working skills (Riede 2007a, 2008a). Indeed, this culture can be defined as a monophyletic clade (an ancestor and all its descendants). Interestingly, the tanged point groups (the Bromme [clade A] and Ahrensburgian [clade B] taxa in clade C) are subgroups of the Arch-backed Point complex (ABP: the Late Magdalenian and Federmesser tradition; clade D). Phylogenetically, they are not therefore equivalent units and cannot be separated at the level of a "culture". Hierarchical schemes for subdividing Late Glacial cultures are not, of course, new (Kozlowski 1999; Schwabedissen 1954), but framing such a hierarchy explicitly and on the basis of individual artefact morphologies provides a useful starting point for exploring the processes that created these hierarchical patterns in the first place. For instance, elsewhere I use this phylogeny to explore whether the introduction of domestic dogs played a role in enabling and structuring the Late Glacial recolonisation process (Riede 2010b, 2011). Long presumed to have been important in this process (Eriksen 1996, 2000), this key "innovation" can be seen as part of the human constructed niche (Bleed 2006), and in investigating this niche construction process it is critically important that, following Galton, we control for the historical relatedness of the units under study (Odling-Smee et al. 2003).

While there are no straightforward means of deciding which level of branching defines an archaeological "culture", workers can now decide which clades or components of the tree may collectively be referred to as a "cultural" group. In any case, we now have an explicit hypothesis of historical relatedness of craft lineages manifest empirically in the archaeological record. Even simple trees are not straightforward in their interpretation (Sandvik 2008). The picture of Late Glacial technological diversity suggested here is perhaps somewhat more complicated than previously proffered schemes, but it arguably constitutes a significant improvement over previous unilineal, typological schemes in that it facilitates further analysis. The great strength of evolutionary analyses is that they often reveal counter-intuitive insights and that they draw our attention towards new avenues of investigation.

Conclusion

In 1847, William Whewell (1847, 637) noted that "Comparative Archaeology", along with geology and historical linguistics is a historical science that is conducted differently to fields such as physics and chemistry. Historical events, he added, are contingent, necessitating the parallel investigation of patterns *and* processes of change and causality (see also Bintliff 1999 and O'Brien and Lyman 2000 for more recent discussions). A little later, Darwin proposed a mechanism that produces these sequences of contingent changes in the biological world, and shortly after the publication of his *Origin* some 150 years ago references to this mechanism – descent with modification – became more common in some archaeological writings. Montelius, for instance, picked up on the similarities between palaeontology and archaeology suggesting that there is much methodological and epistemological overlap. However, the early part of the twentieth century saw an "eclipse of

Darwinism" (Huxley 1943, 22; also Bowler 1983) and an intellectual fragmentation of the sciences. The revolutionary rejection of essentialism and typological thinking in biology, whose implications for unit-building are profound and still debated today, had passed by the archaeological establishment (see discussions by Sackett 1991 for a discussion of this with regards to French Palaeolithic research, and O'Brien and Lyman 1999, 2000 for a more general treatment from an American perspective).

It is argued here that the bottom-up construction of units for diachronic cultural studies rooted in individual technological action provides an empirically grounded rationale for the application of phylogenetic methods to archaeological data. Although numerous scholars, especially in Eastern Europe (e.g. Kozlowski and Kozlowski 1979) have used explicit taxonomic approaches to archaeological classification and even tree-building and network methods for data analysis (e.g. Burdukiewicz 1986; Schild 1984), these were methodologically flawed. Contemporary phylogenetic principles were not readily adopted in Eastern Europe and Russia (Todes 1989) and this may be reflected in the use of phenetic rather than phylogenetic methods in archaeology. It is argued here that detailed technological analyses allow us to construct units of analysis that index "culture" as a system of social information transmission (Boyd and Richerson 1985). Placing these units in nested hierarchies of increasingly exclusive shared attribute constellations facilitates both the definition of "cultures" – strictly perhaps as monophyletic clades – as well as the comparative analysis of casual processes acting upon these units in the first place. Ultimately, which clades or clusters of clades we designate as a "culture" is an arbitrary decision. Archaeological data provide access primarily to the actions of past people as manifest in durable material culture. If we build our definitions of "cultures" from this database, any such definition will not be equivalent to those used by ethnographers. Artefact types are the common "idiom of description" (Sackett 1999, 115) in archaeology, and talking of archaeological "cultures" is certainly a useful linguistic convention. As such the notion cannot readily be abandoned, but much like the typological approach as a whole, it holds only limited analytical utility (see Bisson 2000 for an archaeological argument, and Levit and Meister 2006 for a biological one). In contrast, a phylogenetic definition of archaeological cultures based on an explicit use of ATUs that reflect past human actions renders such groupings analytically tractable.

We must not forget, however, that phylogenies are always merely *hypotheses* of relatedness based on current knowledge and characters that are specific to a given dataset. Although a phylogenetic definition of "culture" may not be epistemologically unassailable (Lee 2003; Lee and Skinner 2008), Pagel (1994, 30) has stressed that "pragmatism is a virtue in science, and…strict adherence to epistemological criteria, although laudable in principle, can often hinder rather than promote the understanding of empirical phenomena". Here, I endorse such a pragmatic stance and have presented first steps towards an operational definition of culture under the umbrella of evolutionary archaeological theory. A cultural phylogenetic framework demands explicit units, but it makes these units comparable and it opens the door to further, empirical analyses that rely on the construction of precisely such units.

The tracing of individual craft lineages for a single class of tools is the first step in a more comprehensive analysis of material culture (Riede 2008b; VanPool et al. 2008). Methods for collating and comparing phylogenies that are historically associated are available (Page 2003; Page and Charleston 1998) and hold the promise of building more synthetic pictures of cultural evolution that draw on a wide range of craft production domains (e.g. lithics, ceramics, artistic production; Riede 2009b; Tehrani et al. 2010). The conceptual overlap between the data employed, and the analytical challenges faced by evolutionary biologists and archaeologists may warrant the application of such co-phylogenetic approaches. Unfortunately, there is still considerable misunderstanding about the remit, goals and limits of an evolutionary archaeology (see Kristiansen 2004; Shennan 2004a and Henrich et al. 2008 for discussions), but with regards to the definition of archaeological cultures evolutionary archaeologists "understand the problem of units and scale, accepting that a cultural phylogeny represents in only the broadest of terms the path that most of the members of a culture followed…The key word is *broadly*; no phylogeneticist would view a cultural phylogeny using "cultures" as taxonomic units as anything but a broad picture of ancestry" (O'Brien et al. 2008, 54). The mere definition of cultures, however, is not the ultimate goal of anthropology or archaeology. What we are interested in is addressing and explaining processes of culture change in the past. It is quite clear that traditional, implicit, typological definitions of culture are analytically moribund: "culture is everything to anthropology, and it could be argued that in the process it has also become nothing" (Foley and Lahr 2003, 109). The approach outlined here suggests a rather narrower, reductionist, and knowledge-centred definition of culture. It promotes a return to a more decidedly comparative archaeology in the sense of Whewell and Hildebrand and in so doing it offers new ways to examine the processes of culture change that are at the heart of archaeological inquiry.

Appendix 13.1

List of all traits measured and calculated. For similar attempts at describing Late Glacial armature shape see Fischer (1985), Burdukiewicz and Schmider (2000), Ikinger (1998), Szymczak (1987), Madsen (1992, 1996), Hahn (1993), and Beckhoff (1967).

I. Maximum length
II. Maximum width
III. Maximum thickness
IV. Body/tang ratio
V. Percussion bulb presence and morphology
VI. Tang orientation vis-à-vis bulb of percussion
VII. Tang retouch direction, right
VIII. Tang retouch direction, left
IX. Tang retouch length, right

X. Tang retouch length, left
XI. Hafting notch (presence/absence)
XII. Tang symmetry
XIII. Tang alignment vis-à-vis midline
XIV. Shoulder angle, right
XV. Shoulder angle, left
XVI. Tip angle
XVII. Tip retouch intensity, right
XVIII. Tip retouch intensity, left
XIX. Tip retouch direction, right
XX. Tip retouch direction, left
XXI. Tip retouch length, right
XXII. Tip retouch length, left
XXIII. Tip alignment

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