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The evolutionary analysis of cultural behaviour

Stephen Shennan & Mark Collard

A team of archaeologists and anthropologists from UCL and the University of Southampton has been awarded a large grant by the UK Arts and Humanities Research Board to set up a Centre for the Evolutionary Analysis of Cultural Behaviour.[1] It is one of only ten research centres to be funded in the UK under this new AHRB scheme and is the first in the world dedicated to its subject. Here the Centre's director and a colleague outline its aims and describe two of the first research projects to be undertaken.

The idea that there are similarities between the processes of biological and cultural evolution has a long history in archaeology and anthropology, but in the past 25 years it has attracted much wider interest. This new lease of life for an old idea stems from the recent explosion of public interest in Darwinian ideas and in genetics, together with advances in the study of culture from an evolutionary perspective.

The evolutionary analysis of cultural behaviour

The fundamental idea is that cultural traditions, such as those that are recognized in the archaeological record, can be regarded as similar to genetic lineages. Just as biological reproduction leads to a transfer of information over the generations by genetic transmission, so the process of acquiring information handed down from previous generations can be seen as a process of cultural transmission, but one that takes place in people's minds rather than in the DNA of their reproductive cells. In other words, the way we learn from others acts as an inheritance mechanism by producing behavioural similarities between learners and those they learn from. These similarities cannot be explained by genetic transmission, nor by the fact that the social and natural environments to which one generation adapts tend to resemble those of the previous generation.

The best known version of this idea is Richard Dawkins' concept of the meme[2] (pronounced "meem"), which he proposed as the cultural equivalent of the gene, passed from one person to another by methods outside genetic control, but subject to a cultural version of the processes of selection that affect how genes spread through populations.

Nevertheless, although the concept of the meme has stimulated thinking about the way cultural information is passed on, in many ways it does not get us much further than traditional vague ideas about similarities between biology and culture.[3] It has proved scientifically more successful to take the analogy between genetic and cultural transmission as a starting point for understanding cultural change through the development of mathematical and statistical methods derived from population genetics and biological systematics. The first milestone here was the publication in 1981 of the book *Cultural transmission and evolution: a quantitative approach* by the famous geneticist Luca Cavalli-Sforza and his mathematical colleague Marcus Feldman.[4] The methods and ideas that have been emerging since then are giving archaeologists, and others interested in the processes of cultural stability and change, new tools with which to approach longstanding problems. Furthermore, the fact that the tools are mathematical means that models based on them are likely to have directly testable implications

Unfortunately, most archaeologists and anthropologists are unaware of these new advances. Also, much of the work carried out has remained theoretical, and the theorists involved do not necessarily have a good grasp of archaeological and anthropological issues and data. The new Centre aims to change this, with a series of projects relating to four specific themes:

- ecological dimensions of cultural evolution
- processes of cultural innovation and transmission
- processes of cultural diversification
- spatial dimensions of cultural evolution.

We cannot describe in this short article the full range of projects that the Centre will undertake within these themes, but we can briefly describe two of the initial projects. Both attempt to follow through the implications of regarding culture as the second system (after genetics) of human inheritance and to demonstrate the insights that can be gained by adopting this approach.

Neutral evolution and pottery

One of the surprises in genetics in the 1960s was the discovery that much DNA did not actually code for proteins. In fact, it apparently did not do anything, and hence could not be under any form of selection. It was found that the only factors that affected the chances of a new mutation surviving or going extinct were the mutation rate and processes of random drift that were dependent on the size of the population. This was the basis of the neutral theory of evolution, which is associated with the well known geneticist Motoo Kimura.[5]

It has often been suggested that style and function in cultural artefacts can be seen in a similar light. Some aspects of artefacts are functional and therefore will be subject to selection in terms of how well they perform that function; others are much more free to vary, and it is often assumed that features such as decoration on pottery fit this description and are adaptively neutral. In 1995 the American archaeologist Fraser Neiman developed this idea by using the mathematics of the neutral theory to develop a series of expectations about the amount of variation to be expected in the decoration of a pottery assemblage if the decoration was indeed neutral.[6] He analyzed rim decoration on pottery assemblages from seven successive phases of the Woodland period of the American Mid-West and found that it matched the neutral expectations. He concluded that the patterns of variation depended on changing levels of intergroup contact, which started low, increased and then declined again. The time of highest interaction was also a time when exotic trade goods were widespread. Because the successful transmission of pottery-making traditions depends on long-lasting relationships between teacher and learner, he suggested that the changing levels of intergroup contact related to changes in the level of long-term residential movement of potters between groups.

Richard Wilkinson and Stephen Shennan have recently applied and extended Neiman's methods in a study of patterns of pottery decoration from two settlements of the early Neolithic Linear Pottery culture in western Germany.[7] The two settlements (Fig. 1, LW8 and LB7) are located within a small settlement cluster along the shallow Merzbach valley that was totally excavated in advance of strip mining. A quantitative analysis of the frequencies of the decorative motifs on the bodies of the vessels (Fig. 2) was undertaken by the same method that Neiman had used. In this case the expectations of the neutral model and the amount of variation in the pottery assemblages of the successive site phases did not coincide. Or rather they did for the earlier phases but not for the later ones, where there appeared to have been a deliberate selection of novel decoration types, rather than simple drift. Why the potters were doing this is unclear, but other evidence suggests that it may be related to a concern to establish their own local identity and distinguish themselves from neighbouring groups.

It appears that the mechanisms relevant to change in the Neolithic Linear Pottery culture are not the same as those that operated in the Mid-Western Woodland period. Although the methods used in both case studies are based on the assumption of neutral evolution, they do not inevitably lead to the conclusion that change in decoration is solely a result of innovation and drift. Rather, they provide

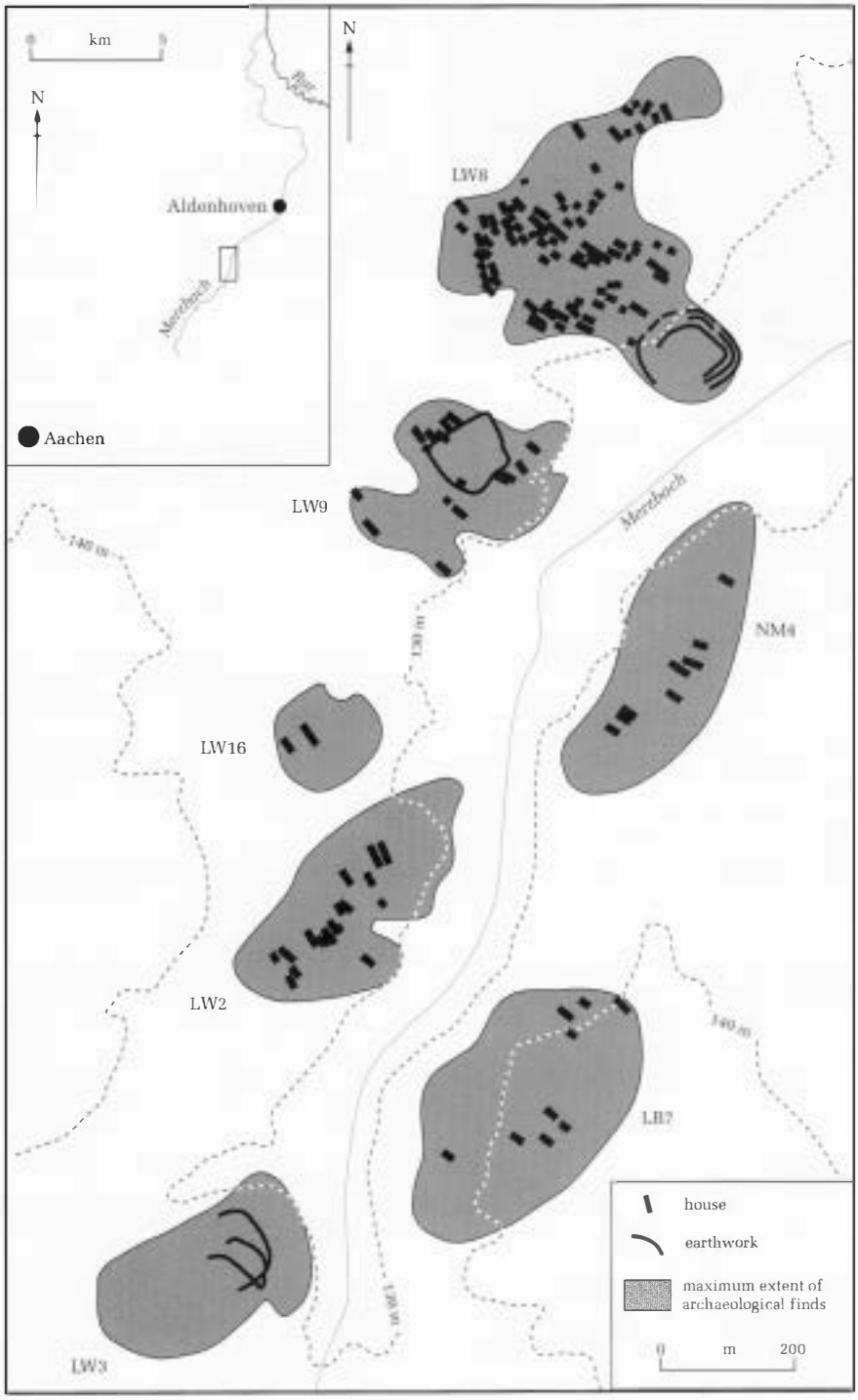

Figure 1 *The distribution of Neolithic Linear Pottery (Bandkeramic) settlements in the middle Merzbach valley.*

a baseline of great predictive value that enables not just neutrality but also alternatives to be identified. If these methods had not been used, any view about the neutrality or active role of pottery-decoration style in any given case would be purely a matter of personal preference. Such questions are of interest to many archaeologists, including those who do not favour the evolutionary approach, but the latter do not have the methods with which to answer them.

Cultural origins: branching or blending?

The second project is concerned with another issue of great general interest: the way in which new cultures or subcultures originate and the way in which these processes relate to genetic and linguistic patterns in human history. Recent discussions of cultural change have focused on two processes that J. H. Moore has termed "phylogenesis" and "ethnogenesis".[8] In phylogenesis a new cultural entity is the result of descent with modification from an ancestral assemblage (branching), whereas in ethnogenesis a new cultural assemblage arises through the blending of elements of two or more contemporaneous entities. Currently, most authors consider blending to be far more important than branching in the generation of cultural entities. However, most assessments of the relative importance of phylogenesis and ethnogenesis in human culture have so far been theoretical and qualitative, or both; only a few attempts have been made to address the problem quantitatively. Moreover, most studies have focused on ethnographic data rather than archaeological evidence.

We have suggested in a recent paper that the issue of distinguishing phylogenesis from ethnogenesis in any particular case is very similar to problems that have already been successfully addressed in the field of evolutionary classification in biology, in estimating the descent relationships among species.[9] Therefore, methods that have been developed in that field of biology could potentially be applied to the analysis of archaeological data.

What the two problems have in common is that they both require similarities existing within a group of species or archaeological assemblages to be divided into those that are the result of shared ancestry and those that are the result of other mechanisms, for example diffusion. In biology this task is accomplished by generating a tree structure that links the species concerned in such a way that the number of hypotheses of change required to account for the observed distribution of similarities is minimized. Using this tree structure it is then possible to classify the similarities as either resulting from shared ancestry or not. The first group of similarities suggests relationships that are compatible with the tree structure, whereas the second implies relationships that conflict with the tree structure.

Influenced by a phylogenetic analysis of stone tools by Robert Foley,[10] we have suggested that this approach could be used to assess the relative contributions of branching and blending processes to patterns in the archaeological record. If a statistically robust tree structure can be derived from a group of archaeological assemblages, then phylogenesis can reasonably be inferred to have played a more important role than ethnogenesis in the generation of the assemblages. Conversely, if such a tree structure cannot be identified, then ethnogenesis can be inferred to be the most important process.

We have analyzed a dataset consisting of the same patterns of pottery decoration analyzed in the neutral-evolution study,[7] but this time from all seven of the early Neolithic settlements in the area (Fig. 1), in order to see if there is evidence for branching or blending in the relationships between the decorative patterns at the different settlements in the different phases.

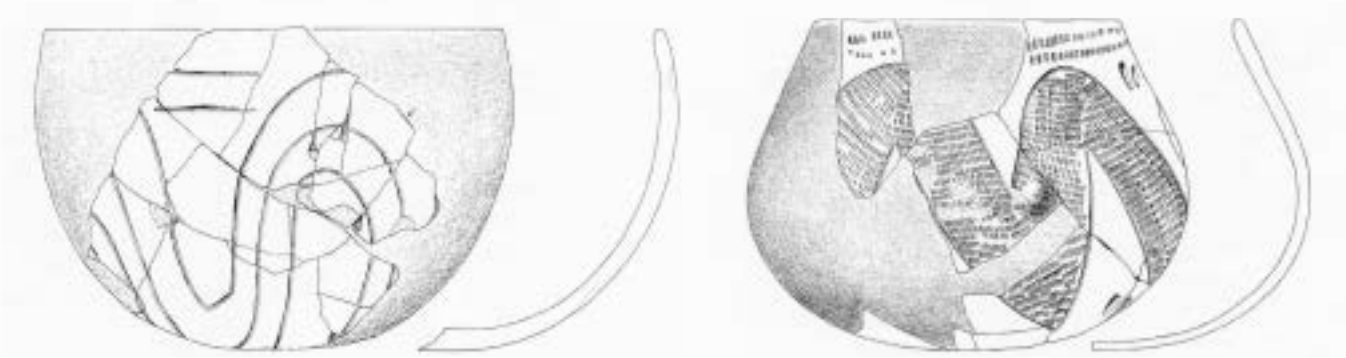

Figure 2 *Examples of early (left) and late (right) Neolithic Linear Pottery (Bandkeramic) vessels from the Merzbach valley.*

The first set of analyses focused on the assemblages from the four settlements that have evidence for occupation throughout the whole of the ten-phase period. It was conjectured that, if the branching or phylogenesis hypothesis is correct, analyses of the assemblages should divide them into the same groups in consecutive phases. On the other hand, if the ethnogenesis or blending hypothesis is accurate, the analyses should separate the settlements into different groups in consecutive phases. The four settlements were divided into the same groups in six of the instances in which consecutive phases could be compared. In the remaining three instances, the settlements were divided into different groups in consecutive phases. These results are not wholly compatible with either hypothesis. Rather, they indicate that phylogenesis and ethnogenesis were both involved in the generation of the pottery assemblages.

The second set of analyses focused on the three instances in the ten-phase period in which a new pottery assemblage appears. It was reasoned that, if the phylogenesis hypothesis is correct, an analysis of the decoration frequencies for one of the newly founded assemblages derive from a single parent in the preceding phase. Conversely, if the ethnogenesis hypothesis is correct, such an analysis should group the newly established assemblage with never less than two of the potential ancestral assemblages. The second set of analyses support the phylogenesis rather than the ethnogenesis hypothesis. Two of the analyses offer strong support for the idea that newly founded assemblages derive from a single ancestral assemblage through descent with modification. The results of the third analysis were more ambiguous, but their simplest interpretation also supports the notion that the newly founded assemblages had a single parent from those in the preceding phase.

The two sets of analyses of the data from the settlements in the Merzbach valley are not compatible with the assertion that cultural assemblages arise predominantly through blending. One important implication of these results is that archaeologists should not simply assume that the cultural entities and assemblages they study are the result of ethnogenesis. Instead, the relative contribution of ethnogenesis and phylogenesis to the generation of the assemblages needs to be determined empirically on a case-by-case basis.[11] A second implication of the results is that the processes of colonization and group fission (when people from existing settlements establish new ones), which are usually assumed to have driven the Linear Pottery early Neolithic expansion into Europe, appear to have the cultural consequences we might expect, and that they were perhaps associated with corresponding linguistic and genetic dispersals. It is particularly striking, given the extensive intersite interaction and close relationships that can be assumed to have existed, that the cultural consequences of group fission so clearly involve cultural differentiation and branching, even at the local scale of the sites analyzed in this study.

Notes

1. The team consists of Stephen Shennan and Mark Lake (Institute of Archaeology), Mark Collard and Ruth Mace (UCL Anthropology), and James Steele and Tim Sluckin (Archaeology and Mathematics, Southampton). Stephen Shennan is the Centre's Director and James Steele its Associate Director. The grant, which is for a period of five years from January 2001, will fund post-doctoral research assistants at UCL and Southampton, computer equipment for mathematical and spatial modelling, a programme of conferences and workshops, and support for visiting scholars. In addition to the grant from the AHRB, members of the Centre will seek further funding for additional projects, and for the continuation of the Centre beyond the initial five years.
2. See pp. 206–7 in R. Dawkins, *The selfish gene* (Oxford: Oxford University Press, 1976).
3. M. Lake, "Digging for memes: the role of material objects in cultural evolution", in *Cognition and material culture: the archaeology of symbolic storage*, C. Renfrew & C. Scarre (eds), 77–88 (Monograph, McDonald Institute for Archaeological Research, Cambridge, 1998).
4. L. Cavalli-Sforza & M. Feldman, *Cultural transmission and evolution: a quantitative approach* (Princeton, New Jersey: Princeton University Press, 1981).
5. M. Kimura, *The neutral allele theory of molecular evolution* (Cambridge: Cambridge University Press, 1983).
6. F. D. Neiman, "Stylistic variation in evolutionary perspective: inferences from decorative diversity and interassemblage distance in Illinois Woodland ceramic assemblages", *American Antiquity* **60**, 7–36, 1995.
7. S. Shennan & R. Wilkinson, "Ceramic style change and neutral evolution: a case study from Neolithic Europe", submitted to *American Antiquity*
8. J. H. Moore, "Putting anthropology back together again: the ethnogenetic critique of cladistic theory, *American Anthropologist* **96**, 370–96, 1994; and "Ethnogenetic theory", *National Geographic Research and Exploration* **10**, 10–23, 1994.
9. M. Collard & S. Shennan, "Processes of culture change in prehistory: a case study from the European Neolithic", in *Archaeogenetics: DNA and the population prehistory of Europe*, C. Renfrew & K. Boyle (eds), 89–97 (Monograph, McDonald Institute for Archaeological Research, Cambridge, 2000).
10. R. Foley, "Hominid species and stone tool assemblages: how are they related?", *Antiquity* **61**, 380–92, 1987.
11. See also P. Bellwood, "Phylogeny versus reticulation in prehistory", *Antiquity* **70**, 881–90, 1996.