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Evolutionary Archaeology
◆◆ Methodological Issues

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I

The Methodological Challenge of Evolutionary Theory in Archaeology

Patrice A. Teltser

◆◆ For more than fifteen years a variety of archaeologists have advocated the application of Darwinian evolutionary theory to explain variation in the archaeological record. Programmatic statements, critiques of traditional anthropological evolutionary models, and considerations of the implications of evolutionary theory have become an increasingly prominent part of the archaeological literature (e.g., Braun 1991; Dunnell 1980, 1982, 1989; Leonard and Jones 1987; Marks and Staski 1988; Neff 1992, 1993; O'Brien and Holland 1990, 1992; Rindos 1984, 1989). This literature has taken a decidedly theoretical direction in recognition that applying evolutionary theory to the archaeological record cannot be accomplished by analogy or simple theory borrowing, but really involves an *expansion* of evolutionary theory as we currently understand it. In short, expanding evolutionary theory to explain variation in the archaeological record requires building new archaeological theory and method.

Even though critiques of traditional evolutionary models from an evolutionary perspective have proven insightful (e.g., Dunnell 1988; Leonard and Jones 1987; Rindos 1986, 1989), and the logic extending evolutionary theory to behavior and the archaeological record is relatively straightforward (as will be discussed below), evolutionary theory has yet to be applied in a cogent way to a significant portion of the archaeological record. It is equally plain that discussions of theoretical concepts have been far less clear about how those concepts translate methodologically and analytically (see Neff 1993 for an exception). This situation is only partly the consequence of a poorly developed theoretical base. Equally important, but given far less attention, are the *methodological* implications and

requirements of evolutionary theory. Taken together, these implications constitute a considerable challenge to evolutionary archaeologists.

In this volume, twelve researchers attempt to provide more concrete methodological expression for expanding evolutionary theory to archaeology. This involves methodological expression for why and how evolutionary explanations differ from more traditional anthropological evolutionary models, why and how different units of measurement must be created, and how these implications carry enormous, but fairly specific, data requirements.

The General Problem

For many archaeologists, explaining variation in the archaeological record in terms of evolutionary processes is an important and legitimate disciplinary goal. While the day-to-day business of our work may not always entail direct engagement with theoretical issues, most archaeologists would hope that their more proximal analytic tasks are directed toward, and in some way contribute to, this ultimate goal. And yet, how we view evolutionary processes on a general level has implications for the way in which more specific analytic tasks are conceived and carried out (cf. Bettinger 1991; Hill 1972). These views, whether implicitly or explicitly recognized, specify the terms in which we conceive of a problem, the causal mechanisms we invoke to explain a particular phenomenon, the observations we consider relevant to solve a problem, the language we choose to make those observations, the way we sample the archaeological record, and the way we might organize our observations and analyze a particular body of data.

These are methodological concerns, the domain of general theory that specifies the measurement of theoretically relevant variables (or dimensions) and the explanation of a particular class of phenomena in terms of theoretically relevant processes. As a subset of theory, method should not be confused with the more common connotation of "procedure" even though it may have procedural implications.

In general, two major sources of variation can be recognized in the archaeological record: that which is the result of human behavioral variation and that which is the result of postdepositional processes. Determining the difference between these two sources of variation is essential to any archaeological theory, evolutionary or otherwise. Understanding and accounting for sources of variation introduced by postdepositional processes is usually placed within the general topic of formation process theory (Schiffer 1988). Understanding sources of behavioral variation is a matter of general or explanatory theory. While there is considerable interaction between these two bodies of theory, the analytic distinction is useful in that the sources and methods associated with them have been quite different. For example, most work carried out to understand sources of variation in the formation of the archaeological record has been conducted within the framework of "behavioral archaeology" (e.g., Reid et al. 1975; Schiffer 1972, 1976, 1987), a research program directed toward studying and explaining the relationships between human behavior and material culture in all times and places. On the other hand, general or explanatory theory stipulates the explanatory basis of those relationships, and research is directed toward determining the empirical and dynamic sufficiency of those theoretically determined relationships.

When the content of explanatory theory and the role of research are stipulated in this way, the subject matter of archaeological explanation is the archaeological record rather than human behavior or motives. This does not necessarily deny a role for human behavior but places it in an explanatory role rather than the role of subject matter. When methodological issues are the focus of concern, criticisms of behavioral reconstruction associated with the evolutionary literature in archaeology (see especially Dunnell 1978, 1982, 1989) are valid to the extent that they take issue with the methodological role which behavioral reconstructions have come to play in many archaeological studies, rather than a denial of the importance of behavioral inferences per se (see Neiman 1990 for a similar argument). Because the archaeological record does not provide any direct observational access to human behavior, the methods used in an evolutionary archaeology will look very different than, for example, an evolutionary ethnography. The chapters in this book address the methodological challenges of expanding such an explanatory framework to include explanation of variation in the archaeological record.

The general difficulties encountered when expanding evolutionary theory to behavior and the archaeological record are primarily twofold. On the one hand, evolutionary theory was formalized in the context of biology, and written and understood almost entirely in biological terms (e.g., genes, organisms, species). Even though biologists have long accepted behavior as an important part of the phenotype, classic evolutionary theory does not include the necessary terms to address behavioral phenomena, much less the products of that behavior as manifest in the archaeological record. On the other hand, anthropologists and archaeologists have been reluctant to embrace an evolutionary framework, and, consequently, the terms in which they conceive their problems and organize their observations are largely incompatible with such a framework. This is most clearly illustrated when one considers the role of theory in specifying how research questions are asked and what kind of observations are required to address them.

To the extent that theory determines the relevance of one question or observation over another, it follows that the terms in which we ask many of the "big questions" of archaeology (sensu Binford 1983) are paradigmatically determined. Consequently, the way in which we have addressed long-standing issues of

archaeological interest, such as the origins of agriculture or the evolution of complex societies, requires a reorientation.

Reorientation of specific archaeological questions is no simple exercise. For example, Rindos (1980, 1984) has only begun to redefine and redirect inquiry into the origins of agriculture in evolutionary terms. This kind of effort is evident in much of the existing literature on evolutionary theory (e.g., Braun 1991; Leonard 1989; Neff 1992, 1993; Neiman 1990, 1995; Rindos 1985, 1986; also Ramenofsky, chapter 7, and Graves and Ladefoged, chapter 8), but Rindos's model for the origins of agriculture remains the most well-developed example. Rindos's success is marked by the ability of evolutionary theory to generate a model for the origins of agriculture that does not ultimately depend on population pressure or climate change, treat agriculture as an "invention" attributed to the omniscience of early farmers, or relegate it to the status of "trait" that can diffuse in much the same way as a ceramic design. Rather, agriculture is defined in terms of specific classes of highly variable behaviors or activities (e.g., planting, protecting, and harvesting) that arise in the context of a specific kind of relationship between plants and people (domestication). The differential persistence of agricultural activities, or the relative frequency with which these activities are performed, determines the degree to which a population at a given point in time and space (e.g., any given "system") is dependent upon them. Defining agriculture in terms of specific classes of *activities* is a significant departure from defining it as a kind of *system* that must be distinguished from other kinds of systems (e.g., incipient agriculture or horticulture).

Criticisms of Rindos's evolutionary model for the origins of agriculture are equally enlightening here. These criticisms usually point to the failure of this model to incorporate the intentions of human actors as causal (e.g., Flannery 1986). While an evolutionary approach would make a distinction between processes that account for the source of behavioral variants (e.g., innovation) and the processes that account for the differential persistence of those variants, the real point of conflict is that an evolutionary model does not incorporate the same terms that traditional formulations of the question require. The difference is paradigmatic. The terms in which evolutionary approaches frame long-standing anthropological problems are likely to differ.

Methodological Implications of Evolutionary Theory

Evolutionary theory is a framework for understanding the differential persistence of variation (Dunnell 1980:38; Lewontin 1970). It applies to biological populations whose members have the capacity to reproduce and transmit information to succeeding generations. Most of evolutionary theory derives from the notion that if there is inherited variation within a population, evolution will

occur. If some of that variation contributes to an individual's ability to survive and reproduce, evolution by natural selection will occur (Lewontin 1970:1; Mayr 1988:117; see also Neff 1993). Extending evolutionary theory to what is loosely regarded as the "cultural" domain is based on the premise that behavior is an important component of the phenotype. Because natural selection acts on the phenotype, behavior—as well as morphology—is subject to evolutionary forces (Dunnell 1989:44–45; Leonard and Jones 1987:213). At the same time it is also recognized that most human behavior is the product of learning. Consequently, applying evolutionary theory to people requires an expansion of classic neo-Darwinian theory to allow for nongenetic mechanisms of transmission and its consequences. Further extending these notions to the archaeological record requires that some classes of artifacts be conceived as part of the behavioral segment of the human phenotype (Dunnell 1989:44).

Evolutionary theory provides a general model in which change is defined in terms of the differential persistence of alternative traits through time. Here, the notion of trait is expanded to include behavioral aspects of the phenotype (regardless of scale) transmitted through learning processes; and differential persistence does not imply the action of any particular causal mechanism. This basic model carries specific methodological implications.

First, the notion of differential persistence implies the transmission of information. That is, evolutionary change occurs within historically related populations wherein information is transmitted and evolutionary explanations are relevant to features that are transmitted through an inheritance system. Consequently, some means to measure the transmission of information is required for evolutionary studies (Teltser, chapter 4, and Neff, chapter 5).

Recognizing learning processes (cultural transmission) as a system of inheritance is one of the primary ways that studies of cultural evolution require an expansion of classic evolutionary theory. The consequences of nongenetic transmission are still poorly understood and theoretically contentious, opening the door to entirely new kinds of research into learning processes in general. For example, information transmission through learning is not confined to parent-offspring relationships or traditional biological generations. This has implications for the rate of change (Rindos 1985) as well as the scale at which some evolutionary processes could potentially occur (Dunnell, chapter 3). Furthermore, nongenetic transmission of information does not necessarily imply reproduction. Consequently, some authors have argued that these complexities of cultural transmission could establish conditions under which additional mechanisms are operative to sort variation during transmission (e.g., biased transmission, see Boyd and Richerson 1985). Since the consequences and the conditions under which such mechanisms operate are so poorly understood, other authors have taken a more pragmatic and parsimonious position by using the notion of replicative success

(Leonard and Jones 1987:214). This concept applies only to the differential persistence of the traits themselves, making no assumption regarding the biological fitness or reproductive success of their bearers. While this concept is not without theoretical and empirical problems, it does provide a useful temporary solution in some cases. Preliminary consideration of nongenetic mechanisms of transmission has raised a number of important, and as yet unresolved, questions. No doubt additional questions will be raised in the future. Most of these questions are ultimately empirical issues. Regardless of how they are resolved, an evolutionary archaeology requires a set of well-developed methods to measure and track the transmission of information.

Second, the notion of differential persistence of alternative features suggests that change is quantitative, not qualitative (Dunnell 1980:38). Actually, this is only a methodological expression of the distinction between population thinking and typological thinking (Mayr 1959; Hull 1967; Sober 1980). When change is conceived in terms of frequency changes of *analytically* discrete features, the scale of analysis shifts from systemic entities, such as phases or cultures, to the individuals that comprise those entities. Appreciating the appropriate scale at which evolutionary processes occur and the characteristics of the empirical entities on which they operate (Dunnell, chapter 3) has important consequences for the appropriate scale of analysis. Indeed, the difference between defining agriculture in terms of certain classes of analytically discrete behaviors or activities rather than a kind of system illustrates just such a shift in analytic scale. Furthermore, the quantitative nature of change has obvious implications and requirements for how we sample the archaeological record.

Third, the notion of differential persistence says nothing about the source of variation, only about the sorting or patterning of variation through time. In a Darwinian framework, evolution is conceived as a two-step process in which the introduction of new variation is independent of (i.e., governed by different mechanisms than) the processes that pattern that variation through time. The concept of undirected variation is a somewhat contentious issue for anthropologists on a theoretical level because it does not specify human intention as causal to the direction of evolutionary change. This topic, including the role of human intention, has been considered in some detail (Dunnell 1980:60–63, 1989:38–39; Rindos 1989). The Darwinian position taken in regard to undirected variation differs from the Lamarckian position in which the introduction of variation is controlled by selective forces. As Dunnell points out, the Lamarckian position is not used in contemporary evolution because no mechanisms have been identified whereby selective conditions generate variation. "The key point is, however, that Lamarckian evolution is not inherently unscientific; it is rejected because current understanding of mechanisms renders it *unparsimonious* in relation to the Darwinian model. *The choice between the two is empirically founded.* Should a general mechanism for generating directed variation be documented, Lamarckian evolution would become just as valuable to science as Darwinism has proved to be" (Dunnell 1989:39, emphasis added).

Traditionally, emphasis has been placed on the role of natural selection as the primary mechanism responsible for sorting variation through time. This emphasis is particularly evident in the archaeological literature (e.g., Dunnell 1980, 1989; Leonard and Jones 1987; O'Brien and Holland 1990, 1992; see Jones et al., chapter 2, and O'Brien and Holland, chapter 9) where reference to an evolutionary program is sometimes referred to as a "selectionist" framework. Despite this bias, evolutionary theory also incorporates other mechanisms such as immigration, drift (Teltser, chapter 4), linkage of neutral traits with those that are under selection (Ramenofsky, chapter 7), in addition to the role of historical contingency (Gould 1989; Neff 1992). Such mechanisms are taking on an increasingly more prominent role in evolutionary studies to account for the differential persistence of variation. The expectations generated by such mechanisms require methodological consideration in much the same way that natural selection has been considered.

The differential persistence of variation can be explained in one of two general ways. Features that directly affect an individual's potential to survive and reproduce can be attributed to natural selection or deterministic processes, while those features that are neutral with respect to selection can be attributed to transmission processes alone. These definitions of function and style (Dunnell 1978) imply different kinds of distributions in time and space. Generally, those features that are under selection will exhibit nonrandom distributions in relation to environmental constraints, while those that are neutral with respect to selection will display random distributions. Even though different kinds of distributions can suggest the nature of different kinds of causal mechanisms operative, additional information regarding mechanisms of interaction is required. For example, nonrandom distributions of traits can result from their linkage to other traits under selection. Here, evaluating differences in potential fitness of alternative features through comparative or engineering analyses has been suggested (e.g., Maxwell, chapter 6; Neff 1992, 1993; O'Brien and Holland 1992) to further assess the nature of causal mechanisms. This not only emphasizes the complimentary relationship between functional/mechanistic and evolutionary explanations, but also emphasizes the notion that different features affect fitness only in relation to the environment in which they occur. To establish the nature of the causal mechanism responsible for the patterning of variation (whether it be spatial or temporal), and ultimately the extent to which natural selection or other mechanisms are operative, requires both mechanistic and distributional kinds of information and description. This ultimately depends on understanding the historic context in which specific changes occurred.

In summary, evolutionary theory generates a series of expectations in which change is treated as the differential persistence of alternative features through time. This model gives methodological expression to many of the basic theoretical aspects of evolutionary theory. These methodological issues specify that evolutionary change occurs within empirically and historically related populations requiring methods to measure information transmission; that change is measured in terms of changes in the frequency of analytically discrete features or variants; and finally, that understanding the mechanisms responsible for evolutionary change is context specific, requiring both distributional and mechanistic kinds of information and descriptions. Unfortunately, evolutionary theory, as currently formalized, provides no further guidance regarding the specific terms and methods by which this framework can be extended to explain variation in the archaeological record. The solutions to these problems must be anthropological in nature. Biological solutions (to the extent that we are biological creatures) will be necessary but not sufficient because evolutionary theory has yet to integrate behavior and nongenetically transmitted information into its program either formally or analytically.

The authors of this book attempt to meet the methodological challenge of finding solutions to these problems. The first three chapters do so from a theoretical perspective; the following four chapters do so in the context of specific topics. Jones, Leonard, and Abbott (chapter 2) begin with a discussion of how the structure of evolutionary explanations differs from the structure of other explanatory frameworks. While this discussion covers some familiar territory (e.g., Dunnell 1980, 1982; O'Brien and Holland 1990, 1992), the authors specify the methodological implications and advantages of evolutionary explanations. In chapter 3, Dunnell extends the discussion to the definition and identification of units of evolution. Using the biological concept of "species" as an example, he points out that while it is a problematic concept for biologists, there is far more agreement about the characteristics of units that evolve and units that are selected. At issue is determining precisely what empirical entities meet those criteria. By focusing on the scale at which evolutionary processes occur, and drawing from these theoretically specified characteristics (and taking into account the nature of archaeological data), it is possible to identify units of selection and evolution in archaeological analysis. In chapter 4 the issue of unit formation is extended to the measurement of information transmission through the method of frequency seriation. By separating frequency seriation as a method from the overall explanatory framework of culture history, the questions of how and why this method is consistent with an evolutionary archaeology can be specified. This historical treatment emphasizes how evolutionary theory can potentially subsume, on an explanatory level, the more cogent historical methods (and results) generated by previous archaeological work.

In the following four chapters, the methodological implications of evolutionary theory are examined in the context of specific research topics. Neff (chapter 5) uses compositional analysis of ceramics to identify historically related pottery traditions and to assess the nature of selective agents in the evolution of serving vessels during the Classic and Post Classic periods in Guatemala. In chapter 6, Maxwell uses engineering analysis and the comparative method to formulate and assess hypotheses about the nature of selective agents operating on rock-mulch fields among late prehistoric agricultural populations in the lower Rio Chama of New Mexico. These methods have long since been important to historical or archaeological research and, in this chapter, Maxwell specifies the articulation of these methods in an evolutionary framework. Ramenofsky (chapter 7) evaluates frameworks for the explanation of artifact change during the post European contact period. In redefining this topic in evolutionary terms, she presents this phenomenon as one with the potential to examine the role of sorting at different scales of inclusiveness. Graves and Ladefoged (chapter 8) take on the task of redefining a topic of long-standing concern into evolutionary terms. These authors examine the timing and distribution of ritual architectural features in Polynesia. Their analysis emphasizes some of the complementary aspects of ecological and evolutionary frameworks by specifying precisely which aspects of the same phenomenon each framework is capable of addressing. The final chapter provides a concluding overview for this volume. Here, O'Brien and Holland make a rather critical assessment of evolutionary theory as a paradigm, and specify those aspects of evolutionary archaeology over which there is emerging disagreement.

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