sites. Evans himself actually found a stone hand axe in the same level as the bones of a hippopotamus. The sheer quantity of the finds convinced Evans and the archaeologist Joseph Prestwich that here, at last, was scientific proof for the great antiquity of humankind, something the new theories of uniformitarianism and evolution had made intellectually possible. In June 1859 John Evans addressed the Society of Antiquaries in London and stated: "This much appears established beyond doubt, that in a period of antiquity remote beyond any of which we have hitherto found traces, this portion of the globe was peopled by man" (Evans, 1860).

There followed rapid and fairly general acceptance of the idea, as a scientific fact, that human beings had been living on this earth longer than six thousand years. The great biologist Thomas Huxley (1825–1895) took up the cudgels on behalf of Darwin's ideas, saying that evolution "will extend by long epochs the most liberal estimate that had yet been made of the Antiquity of Man." In his classic work *Man's Place in Nature* (1863), Huxley compared the Neanderthal skull with those of chimpanzees and gorillas. He also posed the "question of questions for mankind . . . the ascertainment of the place which man occupies in nature." Modern paleoanthropologists still wrestle with this question.

The spectacular social and economic changes generated by the Industrial Revolution in the early nineteenth century engendered great interest in ideas of human progress. In 1850 the sociologist Herbert Spencer (1820–1903) declared: "Progress is not an accident, but a necessity." And the establishment of human antiquity gave archaeologists the open-ended time scale for measuring such progress. The oldest finds were Perthes's Somme valley stone axes, while later prehistoric peoples settled in the sheltered river valleys of southwestern France at a time when reindeer, not hippopotami, were living in western Europe. There followed the celebrated Swiss lake dwellings, villages occupied by much later farming peoples, and then the familiar civilizations of Egypt, Greece, and Rome. This simple, almost linear, framework has long been supplanted by far more elaborate formulations, which assume human biological and cultural evolution has proceeded along many diverse paths throughout the world. A century and a half after John Evans and Joseph Prestwich visited the Somme valley, modern archaeological science has vindicated their conclusion that the frontiers of human history lay far beyond the narrow confines of biblical chronology.

[*See also* Boucher de Perthes, Jacques; Darwin, Charles; Europe, Archaeology in; Evans, Arthur.]

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Brian M. Fagan

EVOLUTIONARY ARCHAEOLOGY

Increasingly over the last several decades, archaeologists have begun to take note of the fact that Darwinian evolution offers a powerful means of explaining variation in the material record. Evolutionary approaches have been around in archaeology since the late nineteenth century, but with rare exception have they borne even the slightest resemblance to Darwin's approach. Rather, they stem directly from the progressive evolution promoted in the nineteenth-century by the ethnologists Edward B. Tylor and Lewis Henry Morgan and resurrected in the mid-twentieth century by Leslie White and Julian Steward. Occasionally, prehistorians have realized this lack of congruence, including A. V. Kidder, who in 1932 pointed out that archaeologists, noting that modern biology had gone beyond the bounds of taxonomic ordering, were attempting to follow that science into the more alluring fields of philosophic interpretation. Kidder further noted that unlike biology, archaeology failed to possess the foundation needed for such a movement.

Kidder's remarks are important because they indicate how at least one early American archaeologist viewed the phenomena he was studying: Cultures evolve; a historically documented culture has a developmental heritage, or lineage, and it is the job of the archaeologist to describe that lineage and determine why it has the form that it does. But Kidder correctly indicated that archaeology lacked both the basic data and a theory consisting of cultural processes parallel to the biological ones of genetic inheritance and natural selection to help explain a culture's lineage in evolutionary terms. Worse, archaeology lacked an objective means of documenting variation in a manner consonant with a Darwinian approach. Without the means to document variation and then to link that variation to applicable theory, which dictates how and why variation is measured, explanations of how and why things change—the epitome of an evolutionary approach—are simply untestable interpretations about the past.

Some of Kidder's contemporaries argued that because cultural evolution occurred much more rapidly than biological evolution, Darwin's ideas were not applicable to the archaeological record. This viewpoint picked up steam in the 1940s—ironically, at the same time that modern synthesis was occurring in evolutionary biology—and reached its zenith with the widely held sentiment that phylogenetic (heredity-based) relationships do not exist between inanimate objects. During the next several decades virtually all anthropologists and archaeologists ignored Darwinian evolution in favor of White's (1959) brand of cultural evolution, with its emphasis on function and a definition of culture as humankind's extrasomatic means of adaptation. Whitean evolution became the cornerstone of processual archaeology in the 1960s, largely at the hands of Lewis Binford.

Processualists occasionally made reference to Darwinian evolution, but it was not until publication of Robert Dunnell's (1978) "Style and Function: A Fundamental Dichotomy" and "Evolutionary Theory and Archaeology" (1980) that there was an incipient programmatic statement on how to write that particular kind of evolution in archaeological terms. Dunnell's early work was met largely with silence, and although occasional articles appeared throughout the 1980s, it was not until the 1990s that evolutionary archaeology attracted more than modest interest. During that decade, the number of articles and books grew exponentially and continues to grow. Some of these focus on method or on rewriting the theory in archaeological terms, but many are case studies of how Darwinian evolutionism can be applied to particular portions of the archaeological record.

Evolutionary archaeology today mirrors where evolutionary biology was in the days following the synthesis of the late 1930s and early 1940s, when there was not only methodological disparity but also theoretical division among geneticists, neontologists, and paleontologists. In archaeology there is a division not only between evolutionary archaeology and behavioral ecology but also between evolutionary archaeology and behavioral archaeology. All three, to varying degrees, view behavior as a phenotypic (physical) characteristic, just as they view behavioral by-products—pots, projectile points, and the like—as phenotypic characteristics. And archaeology, of all possible disciplines, has access to past phenotypes and thus to the one thing that grounds any evolutionary study—history. At issue is how best to study that history.

Evolutionary Archaeology and Paleobiology. Evolutionary archaeology has more than metaphorical parallels to paleobiology in that both are geared toward providing Darwinian explanations of a material record. Put simply, evolutionary archaeology comprises writing descriptions of the historical patterns of differential character representation and testing theoretically derived hypotheses as to how and why evolutionary processes acted to create those patterns. Both steps use concepts embedded within Darwinian evolutionism, including lineage—a temporal line of change owing its existence to heritability; sorting mechanisms such as natural selection; transmission mechanisms and pathways; and innovation—a source of novelties similar to genetic mutation and recombination. Heritable continuity, or fidelity of replication, ensures that what is being examined is change within a lineage rather than merely a temporal sequence or a case of convergence.

Evolutionary archaeologists agree with the long-recognized points that cultural lineages not only diverge but also converge and intermingle, and thus cultural evolution comprises instances of anagenesis (nonbranching evolution), cladogenesis (branching evolution), and reticulation. Further, evolutionary archaeologists clearly recognize that the tempo of change can vary significantly both within and between lineages. The historical aspect of Darwinian evolutionary theory is meant to address how and, more particularly, why a particular form came to exist. That is the hallmark of evolutionary archaeology.

Evolution comprises change in the composition of a population over time, and in evolutionary archaeology the population comprises artifacts. Extension of the human phenotype to include ceramic vessels, projectile points, and the like is based on the notion that artifacts are material expressions of behavior, which is undeniably phenotypic. Some have viewed this extension as problematic, but this view is not held widely outside anthropology. Biologists routinely view things such as spiders' webs and beavers' dams as phenotypic characters. Archaeology's unique claim within the natural sciences is its access to past phenotypic characters. Ethnographers, historians, and others who study humans are limited to studying living humans or written records; only archaeologists have access to the entire time span of culture, however one chooses to define it.

The significance of this statement is found in a parallel with paleobiology. Some biologists might protest that the fossil record is unnecessary to determine the phylogenetic history of organisms, but this position is losing ground as paleobiologists more frequently use the fossil record to help test hypotheses of ancestry. The important point is that historical questions are the most obvious ones archaeologists can ask. If the issue is evolution, then historical questions must be asked. This in no way implies that historical questions are the only ones that must be posed, but they are the ones that address why certain manifestations occupy particular positions in time and space.

Lineages and Evolutionary Mechanisms. Any evolutionary investigation is a two-step process. First, lineages are constructed, here cultural lineages, and second, explanations are made for the lineages being the way they are. With Darwinian evolution as the guiding theory, the first step comprises the documentation of descent with modification, and the second step involves the identification of the mechanisms that caused the changes or periods of stability within the lineage. Accomplishment of the first step requires tight chronological control and documentation of heritability between the archaeological manifestations comprising the lineage. Accomplishment of the second step requires that hypothesized mechanisms such as natural selection that result in sorting be tested during periods of change and that the hypothesized absence of sorting (presence of stabilizing mechanisms) be tested during periods of stability. The analytical challenge is to determine which is applicable in any given situation. Explaining why a lineage has the appearance it does demands that the uniqueness of historical contingencies and configurations be considered.

Evolution, or descent with modification, comprises net directional change or cumulative change in the characteristics of populations over many generations. Implicit in this definition is the requirement of heritability effected by transmission and the resultant replication of ancestral forms by descendant forms. This is what makes evolution distinct from mere change: Fidelity of replication resulting from transmission results in descendant phenomena resembling to greater or lesser degrees their ancestors. Evolution has three requirements: (1) variation among individuals exists at some scale, (2) there is inheritance of variant characteristics, which requires transmission, and (3) there is differential representation of variants across generations (variants are replicated at varying frequencies).

Units and Transmission. Natural selection results in sorting, but so do the vagaries of transmission.

One analytical challenge squarely faced by evolutionary archaeology is to determine when sorting results from transmission mediated by natural selection and when it results merely from the randomness of transmission. This challenge is addressed by particular analytical units constructed to measure each kind of sorting. Making the matter more difficult is the fact that the fidelity of replication can vary by scale, which must be dealt with analytically on a case-by-case basis, and that depends on the analytical units used.

Evolutionary archaeologists have spent considerable time debating the merits of various units that have been proposed to track phenotypic change through time—a perhaps not unexpected occurrence given the centrality of unit construction in archaeology from the start. The distinction has been consistently made between two kinds of units—empirical (real) units and theoretical (measurement) units—the latter defined as units that have explanatory significance because of and only because of their theoretical relevance. Much of the empirical research that has been done in evolutionary archaeology has bypassed traditional archaeological units and employed a particular kind of theoretical unit, the class, which is a measurement unit that specifies the necessary and sufficient conditions that must be displayed by specimens in order for them to be identified as members of that class. The important point here is not that evolutionary archaeology sees no role for traditional units such as named artifact types, because some of those traditional units are excellent at what they are supposed to do, such as tracking the passage of time, but even the most useful types are not multipurpose units. Neither are the classes constructed by evolutionary archaeologists. Rather, they are useful for specific analytical purposes.

One purpose is the examination of transmission—how cultural traits, attributes, and the like are passed down through generations, creating traditions, and across single generations. Modes of transmission and how various modes bias what is transmitted play a large role in evolutionary biology, and the situation is no different in archaeology. From a methodological standpoint, recognition of the importance of transmission underlies all approaches used to reconstruct cultural lineages, including seriation and cladistics. Evolutionary archaeologists did not "discover" the importance of transmission as a research topic. Archaeologists have long had interest in cultural transmission, which is nothing more than a new term for diffusion in various guises.

Despite advances made by archaeologists in understanding the transmission process, perhaps the most significant advances from an evolutionary standpoint have been those by nonarchaeologists, including Luca Cavalli-Sforza and Marcus Feldman (1981) and Robert Boyd and Peter Richerson (1985). This collective work is often referred to as dual-inheritance theory, and although there are significant differences among the various authors in terms of how they view the transmission process, there are enough similarities that they can be seen here as complementary. Dual-inheritance theory posits that genes and culture provide separate, although linked, systems of inheritance, variation, and evolutionary change. The spread of cultural information is viewed as being affected by numerous processes, including natural selection, decision making, and the strengths of the transmitters and receivers.

For the Future. In the end, for evolutionary archaeology to attain its promise, those involved in its formulation are going to have to be clear about such basic issues as what it is that evolves and how evolutionary change is to be measured. And they are going to have to be more accommodating of other intellectual approaches that are incorporating elements of Darwinian theory, such as behavioralism and human evolutionary ecology. These theoretical and methodological challenges originate from sources or concerns peripheral to the central topics for evolutionary archaeology—transmission, selection, and descent with modification, and how these are to be studied in the archaeological record. Other challenges arise from sources internal to these central topics. For example, there is disagreement over fundamental issues such as fitness and whether artifactual units can be used to examine human fitness. Some archaeologists are of the opinion that although artifacts can be examined in terms of artifact fitness—how well one kind of artifact out replicates another kind—that particular kind of fitness has no bearing on human reproductive success. Other evolutionary archaeologists disagree with this view, in part because the "replicative success" of an artifact type may be driven by natural selection working on the replicators (humans), by natural selection working on the interactors (artifacts), by the vagaries of transmission, or by some combination thereof such that one evolutionary process or the other applies at different times.

What is important in Darwinian evolution is that variation, however it is generated, exists, and that transmission, however it is realized, takes place. Reproductive success among variant forms of organisms will result in large part (although not exclusively) from selection, drift, and mentalist processes. Similarly, replicative success among variant artifact forms will result from the same processes. Thus evolutionary archaeologists would not agree with the view that the phenomenon of cultural evolution be labeled cultural development rather than "evolution" because the latter carries too many biological connotations. The Darwinian mechanisms of selection and transmission, when incorporated into an explanatory theory, provide precisely what archaeologists have always sought: the tools to begin explaining cultural lineages—that is, to answering why-type questions. As D. C. Dennett (1995) put it, the power of Darwin's theory of natural selection is not in proving exactly how (pre)history was, but only the power to prove how it could have been, given what we know about how things are.

Finally, it is worth noting that some archaeologists view Darwinian evolution as having absolutely no relevance to archaeological inquiry. As the basic argument goes, evolution must be viewed strictly in terms of changes in gene frequency. Given that archaeologists do not have access to genes, Darwinism thus has little to offer archaeology except in a metaphorical sense. This view overlooks the fact that even biologists do not view evolution as strictly a gene-based process. J. A. Endler's (1986) definition is typical: net directional or cumulative change in the characteristics of organisms or populations over many generations—in other words, descent with modification. Endler (1986) also states that evolution is more than merely a change in trait distributions or allele frequencies. Once viewed in such light, the claim that Darwinism has no role in archaeological inquiry can be dismissed.

[*See also* Behavioral Archaeology; Binford, Lewis; Darwin, Charles; Darwinian Theory; Human Evolution, Theories of; Kidder, Alfred; Seriation.]

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Michael J. O'Brien

EXCAVATION

Introduction
Excavation Strategies
Mapping and Recording of Excavations
Artifact Recovery in Excavations
Publication of Findings from Excavations

Excavation: Introduction

Archaeological excavation is one of a number of approaches used to acquire information about human behavior in the past. In the early days of archaeology, excavation was the only technique and in practice it differed little from mining operations. Today, however, it is but one of many techniques. It is a highly refined scientific process and is employed only when justified by a formal research design because of its destructive nature.

Typically, archaeology is equated with excavation, and although this is not strictly true, excavation accounts for a significant amount of the information upon which our current knowledge of the human past is based. Alternatives to excavation include detection and recording of surface-exposed artifacts, remote sensing as in aerial photography and geophysical prospecting, and the examination of soil and plant distributions. The advantage of such approaches is that they are nondestructive and permit widespread coverage of entire landscapes. Yet, at some point in nearly every archaeological project, probing beneath the surface becomes necessary to gain access to the hidden dimensions of the archaeological record.

The allure of buried archaeological deposits lies in their removal, to some degree, from the disturbance suffered by surface exposure. In the extreme, a set of artifacts may become sealed in a deposit which preserves the exact spatial relationships of the event of which they were a part. Deliberate burial creates such conditions, as when artifacts are cached and the dead entombed. Sealed deposits may also result from accidental events such as sudden flooding, avalanches, and volcanic eruptions. Most commonly, however, burial results from the gradual accumulation of materials from geological and cultural processes. Therefore, apart from exceptional circumstances, buried deposits once were exposed and excavation always must take account of this fact.

Before planning an excavation, a site must be located, and this process may employ some of the nondestructive alternatives to excavation. Wide-ranging pedestrian surveys, inspection of remote sensing data, aerial reconnaissance, and regional scale soil survey all may be used for site discovery. Test pitting and shovel testing may also be used to find places that exhibit properties traceable to past utilization of a place. The latter are particularly prominent in cultural resource management (CRM) as it is practiced in the United States.

In planning an archaeological excavation, a process which starts with the formulation of a research problem and ends with the publication of the results of the work, intensive applications of nondestructive