# *Chapter 4*

# Cause

*Michael J. O'Brien and R. Lee Lyman*

## INTRODUCTION

The *American Heritage Dictionary of the English Language* (New College Edition, 1992) provides several definitions of **cause**; the one under consideration in this chapter is, "That which produces an effect, result, or consequence; the person, event, or condition responsible for an action or result." Cause is a central concept in human thinking and probably has been for thousands of years. Why do things happen? Why do they happen the way they do? Why do they happen that way as opposed to another? Why do they happen at a particular time as opposed to another? These kinds of questions are so fundamental that it would be difficult to imagine any sapient organism *not* asking them. Why-type questions, together with the related how-type questions, form the basis of Western scientific inquiry, which is a precise set of procedures designed to ferret out relations between and among natural phenomena and to formulate **explanations,** or reason-giving statements, for how and why those relations come to be expressed at particular times and in particular places.

One problem that occurs in science is a forced reliance on everyday words to refer to highly specific **processes** and **mechanisms**—two terms that themselves are difficult to define. We define "process" as any action or series of actions that produce something, and "mechanism" as a system of parts that function like those of a machine. Perhaps no field of inquiry has been faced with this problem more than Darwinian evolutionism—the study of descent with modification—although a strong case could be made that by extension anthropology and archaeology share many of the same language-based difficulties. When it comes to the word "cause" and all it entails, anthropology and archaeology fare even worse than does evolutionary biology because the subject matter is humans—organisms that seemingly have the capacity to set agendas, to anticipate changing social as well as physical environments, and to create the means by which to change their environments. In short, humans have the appearance of—and testify to—being the causes, or agents, of change. Humans are unique in the scientific world in that no other organism has the luxury of studying itself, let alone studying its behavior and assigning explanations for what caused that behavior. Such luxury comes at a price, however, in terms of potential loss of objectivity.

It could be argued that there is no loss of scientific objectivity because we *know* why we do things and why those things turn out the way they do. Actions and occurrences are the immediate products of intentions emanating from the minds of the doers; human intent—or so the actors tell us—thus becomes the cause of something, and results are explained in terms of that intent. Such a stance, however, lodges explanation within the things to be explained, which renders the explanation circular. Left unanswered is the question of why A occurred as opposed to B, or at a more fundamental level why A and B were available options in the first place. If anything, such explanations deal with proximate, or near-term causes, not ultimate causes. Science, however, is as interested in ultimate cause as it is in proximate cause, and it uses a mix of inductive and deductive reasoning to arrive at causal statements. **Theory**, defined as a set of things and statements about how those things interact that provide explanations, is as important as empirical evidence in such a mix; importantly, it is the key role afforded theory that sets science apart from other sense-making systems.

Lest we be misunderstood, we should point out that there is no single definition of cause that is appropriate for all sciences, nor is there unanimity over the proper role of explanation in the scientific enterprise. Further, we suspect that most scientists are not particularly upset by the existence of multiple definitions of cause or how the concept of explanation is used in different disciplines. In fact, perusal of the literature supports a proposition that philosopher Ernest Nagel (1965: 12) made in the mid-1960s: "It is beyond serious doubt that the term 'cause' rarely if ever appears in the research papers or treatises currently published in the natural sciences, and the odds are heavily against any mention in any book on theoretical physics." Despite this absence, it is clear that scientists today are as interested in causal processes and mechanisms as their predecessors were over two millennia ago.

## HISTORY

The English word "cause" is derived ultimately from the Latin *causa*, which means purpose or reason. Both conceptually and etymologically the word can be traced to the Greek philosophers of the fifth century B.C. and the noun *aitia*, from which is derived *aitiologia* (English *etiology*), the study of cause. Until late in the fifth century B.C., causal explanations were based strictly on philosophical ruminations about the natural world. It is in the work of Plato that we see the beginnings of a marriage between philosophical reflection and **empiricism**, or the view that experience and observation are the paths to knowledge. In the *Timaeus* Plato discussed the origin of the cosmos, arguing that it was created by an intelligent, divine hand that kept it moving toward an ultimate end. **Teleology**, from the Greek word *telos* and referring to the study of natural features and occurrences from the standpoint that there is an overall natural design to them, was part of pre-Platonic Greek philosophy, but so far as we know it received its first in-depth treatment at the hands of Plato.

The notion of a purposive development and an ultimate end reached its greatest expression in the fourth-century B.C. works of Aristotle, but instead of depending on the conscious will of an intelligent designer for the origin and development of the cosmos, Aristotle modeled it as being both empirically sufficient and teleological in and of itself. In other words, Aristotle imbued nature with a vitalistic tendency but bypassed the need for a hands-on creator who constantly tinkered with what he had created in order to keep it moving toward its ultimate and predestined end.

The notion of a divine engineer came to play an important role in Western scientific enterprise throughout the second millennium A.D. Gone was the Aristotelian notion of a world of infinite age, and in its place was the biblical notion of a recently created world. The Bible made clear not only who was responsible for creating the world but also what man's role was in it: "[B]e fruitful and multiply, and fill the earth and subdue it; and have dominion over the fish of the sea, and over the birds of the air, and over every living thing that moves upon the earth" (Genesis 1:28). The Old Testament was the basis for a **natural theology**, or God-centered view of nature and its complexity, which reached a level of prominence through the thirteenth-century work of the Dominican monk Thomas Aquinas, who axiomatized teleology in Western thinking. His *Summa Theologiae* was based on the observation that there is so much order in the universe that there must be a divine creator who directs all natural things toward their proper and ultimate end. Empiricism, which had played an ever-widening role in Greek philosophy, played no role at all in the natural theology of Aquinas and his followers; rather, logic and deduction could provide the necessary answers relative to cause and the explanation of natural phenomena.

The Middle Ages brought about a radical shift in thinking, grounded in mechanics and a search for laws that mechanized the universe—that is, that put matter in motion and kept it there. For the first time, experimental measurement became an inseparable component of science, and the search was on for the identification of regularities in nature. The use of induction to identify the laws behind the regularities—for example, in the work of Polish astronomer Nicolaus Copernicus and Italian astronomer Galileo Galilei—reached a level of sophistication not previously seen in Western science, culminating in the major works of Isaac Newton. Philosophically, the mechanistic view was promoted by Francis Bacon and the neo-Platonic René Descartes, who used his invention, analytical geometry, as a means of teasing out structural relations among natural objects.

Slightly later, English philosopher John Locke attempted to show that despite the existence of mechanical laws that governed matter in motion, no amount of clever thinking could lead to the conclusion that the mind and the thoughts it produces arose out of mere matter and motion. Thus, there had to a thoughtful, intelligent being that preceded, and thus created, matter and motion. It was fruitful to search for laws that governed the inner workings of natural phenomena—these were not denied—but the question as to ultimate causality was already answered.

It may appear as if, by the eighteenth century, there was more or less a consensus among scientists and philosophers over the nature of cause, but a problem was emerging over how much control was being exerted by the intelligent designer. If one adhered to the writings of the physical scientists, then one was forced to conclude that although the designer had created the world, he had after that point kept his interference to a minimum, allowing a few basic laws to steer it forward. In contrast, increasing sophistication of observations of the living world made that conclusion untenable. Whereas physical scientists could study the proximate causes that were manifest by divine law, those studying the living world saw a contradiction. As biologist Ernst Mayr (1982: 103–104) put it,

> Here such a diversity of individual actions and interactions is observed that it becomes inconceivable to explain it by a limited number of basic laws. Everything in the living world seemed to be so unpredictable, so special, and so unique that the observing naturalist found it necessary to invoke the creator, his thought, and his activity in every detail of the life of every individual of every kind of organism.

The naturalists saw perfection in every aspect of the living world, especially in the many and varied aspects of organisms that came to be referred to as **adaptations**—physical features and behaviors that the designer gave organisms to help guide them through uncertain environments. The features appeared to be so perfect, how could they be explained through reference to mere laws? The wedding of naturalism and theology that took place in the latter half of the seventeenth century was announced through such works as John Ray's *The Wisdom of God Manifested in the Works of Creation* (1691), and profoundly influenced the work of eminent eighteenth-century naturalists such as Georges Louis Buffon, Carolus Linnaeus, and Jean Baptiste Lamarck. It reached perhaps its clearest expression in two works: William Paley's *Natural Theology* (1802), appropriately subtitled *Evidences of the Existence and Attributes of the Deity Collected from the Appearances of Nature*, and Robert Chambers' (written anonymously) *Vestiges of the Natural History of Creation* (1844).

The term "natural theology" can also be applied to most geological texts of the late eighteenth and early nineteenth centuries. Received wisdom is that one of the great debates of the period was between uniformitarianists and catastrophists, but this glosses over the more important point that the debate was really over whether there was directionality in the history of the world. The ultimate cause of change, the divine creator, was rarely at issue in the debate; rather, emphasis was on secondary causes. For Charles Lyell, the foremost of the uniformitarianists, the earth's history was one of a steady state, with some degree of cyclicity. Once the earth had been created and life had been placed on it, the creator allowed the story to unfold in concordance with physical laws established to guide proper unfolding. For catastrophists such as Georges Cuvier, the earth's history was a tumultuous one, filled with faunal extinctions and replacements, which gave that history a directional, and to some a progressional, appearance. As opposed to the uniformitarianists, who saw the same causes operating throughout the earth's history, the catastrophists posited a series of causes for the early history of the earth that somehow had ceased to operate later in its history.

Charles Darwin's contribution to the nature of cause was to remove it from the domain of natural theology and to place it firmly on external grounds. Darwin's notion of "descent with modification," expressed so well in *On the Origin of Species* (1859), laid the groundwork not only for modern evolutionary biology but for the investigation of the natural world in general. As opposed to his predecessors, Darwin provided a process and a mechanism for the history of life that relied neither on urges inherent to organisms nor on the invisible hand of a designer. Cause—why things happened historically the way they did—could be answered in a straightforward manner: some organisms had certain features, or qualities, that allowed them to do better in a particular environment than did organisms without those features. The winnowing process that led to the demise of certain organisms, and hence of their **lineages**, or lines of hereditary descent, was **natural selection**. This was an unfortunate choice of terms because it implies that choices are actively being made about which organisms make it and which do not. This is true, however, only in the broadest terms. What really happens is that certain organisms living in particular environments do not have certain features that *allow* them to survive and leave offspring. It is this absence of features in the face of environmental (social or physical) problems that is the selective process.

Darwin had little knowledge of particulate **inheritance**, or what gets passed on intergenerationally through **transmission** (the movement of information—cultural or genetic—from one organism to another), and what he did know was for the most part incorrect, but this was of little significance; his theory of cause worked without his knowing the intricacies. After Gregor Mendel's work was discovered in 1900, geneticists could speak of rules of inheritance, but these were the proximate causes of why an organism had a particular genetic composition. They did nothing to explain why certain genes were there to be inherited and why others were not. Darwin's theory of descent with modification by means of natural selection explained that, and yet Darwin himself did not deny the existence of a divine creator, nor did he always apply his theory to humans, which the Bible states were created in the image of God. Thus, his theory tells us nothing about the "ultimate" ultimate cause—why and how life itself began. It has been only in the closing decades of the twentieth century that we have rudimentary insights into those issues (e.g., Cairns-Smith 1982).

With respect to why and how humans and their behaviors evolve, it is difficult to find a single thread emerging from the time of Plato and Aristotle onward. If there *is* a thread, it is cultural idealism, which might best be summarized by the phrase "mind over matter." The assignment of cause here is simple: man simply has willed himself to a continually higher state of being—a notion widespread in Enlightenment thought and manifest in the works of Locke, Diderot, Rousseau, Voltaire, Montesquieu, and others. Implied in some, but certainly not all Enlightenment works on the history of mankind was the notion of **progress**—rendered in terms of "betterment" or increased "complexity"—and usually subdivided for analytical purposes into stages or phases. Thus, Auguste Comte proposed a three-phase system of human development—theological, metaphysical, and positivist; Montesquieu divided early mankind into savages and barbarians; and Anne Robert Jacques Turgot proposed a three-phase system of hunting, pastoralism, and agriculture. In some cases technological advancement was identified as the proximate cause of mankind, or a portion thereof, progressing from one phase or stage to the next higher plateau. Similarly, the environment, both physical and social, often was invoked as the proximate cause of developmental **stasis**, or a period of no change.

The notion of progress was nowhere stated so clearly as in the writings of Herbert Spencer, who wrote in *Social Statics* (1851: 80) that

> Progress, therefore, is not an accident, but a necessity. Instead of civilization being artifact, it is part of nature; all of a piece with the development of the embryo or the unfolding of a flower. The modifications mankind have undergone, and are still undergoing, result from a law underlying the whole organic creation; and provided the human race continues, and the constitution of things remains the same, those modifications must end in completeness. . . . [S]o surely must man become perfect.

For Spencer, perfection was the result of mankind's long struggle out of a series of lower stages, propelled along its way by underlying laws—with the caveat that not all peoples were equally imbued with the capacity to raise themselves to higher levels. This racial determinism is manifest throughout the late nineteenth century in the writings of numerous social scientists, perhaps most evident in the works of Edward B. Tylor and Lewis Henry Morgan.

For Tylor, it was inescapable that there

> seems to be in mankind inbred temperament and inbred capacity of mind. History points the great lesson that some races have marched on in civilization while others have stood still or fallen back, and we should partly look for an explanation of this in differences of intellectual and moral powers between such tribes as the native Americans and Africans, and the Old World nations who overmatch and subdue them. (Tylor 1881: 74)

Morgan thought likewise, noting, for example, that "The Indian and European are at opposite poles in their physiological conditions. In the former there is very little animal passion, while with the latter it is superabundant" (Morgan 1870: 207). Morgan went further, using comparative data to conclude, in his lengthy treatise *Ancient Society*, that "the experience of mankind has run in nearly uniform channels; that human necessities in similar conditions have been substantially the same" (Morgan 1877: 8).

Morgan's tripartite evolutionary scheme, consisting of savagery, barbarism, and civilization, was an attempt to pigeonhole ethnic groups, often referred to as "tribes," on the basis of the presence or absence of specified cultural traits; and although the scheme appears naive and racially deterministic, it called attention to cultural differences. More important to our discussion here, "in spite of the disfavor into which Morgan's work fell, his general sequence of stages has been written into our understanding of prehistory and interpretation of archaeological remains, as a glance at any introductory anthropology text will indicate" (Leacock 1963: xi).

## CONTEMPORARY USES

Leacock is correct in her assertion that the evolutionary schemes of nineteenth-century researchers such as Morgan have been carried over into modern anthropology and archaeology. What has not been carried over is the racially deterministic component of the schemes, primarily because the twentieth century has witnessed an analytical decoupling of biology from **culture** (Gould 1996)—a complex term that can be defined minimally as socially transmitted behavior. Anthropologists on the whole are quite willing to accept that the evolution described by Darwin is the cause of organismic change over time, but they see an entirely different kind of evolution when it comes to human behavior. This brand of evolution is termed **cultural evolution**, and it became a topic of considerable debate in the 1940s and 1950s, primarily through the work of Leslie White (e.g., 1949, 1959a, 1959b) and Julian Steward (e.g., 1953, 1955). To Steward, White's brand of evolution was "unilinear" and traced its roots directly back to the nineteenth-century notions of Tylor and Morgan; but in reality, Steward, despite his use of the term "multilinear" for his own evolutionism, was as much or more a unlinear evolutionist than White was.

Steward (1953: 15) suggested that the use of cultural evolution as an explanatory model demanded two "vitally important assumptions. First, it [assumes] that genuine parallels of form and function develop in historically independent sequences or cultural traditions. Second, it explains those parallels by independent operation of identical causality in each case." White expressed a similar outlook, noting that the cultural evolutionary process was lawlike (1949, 1959b) and that the sequences of stages was inevitable in the sense that all societies would eventually represent civilizations, whether they all were at one time something else (1947, 1959b). Despite White's (1943: 339) disclaimer that he was not saying that "man deliberately set about to improve his culture," close reading of what he said indicates that he strongly believed all organisms, including humans, had an "urge" to improve and that this was the "motive force as well as the means of cultural evolution." White (1947: 177) also regularly indicated that he and other cultural evolutionists "did not identify evolution with progress [and that they] did not believe progress was inevitable."

However, by default White's cultural evolution *is* synonymous with progress: "[B]y and large, in the history of human culture, progress and evolution have gone hand in hand" (White 1943: 339). In White's view the key evolutionary mechanism—urge or necessity as a motive force—demands absolutely no reference either to a source of variation or to natural selection. Humans thus invent new tools as necessary, and the tools are always better than the preceding ones because they allow the procurement or exploitation of additional energy:

> The best single index [of progress] by which all cultures can be measured, is amount of energy harnessed per capita per year. This is the common denominator of all cultures. . . . Culture advances as the amount of energy harnessed per capita increases. The criterion for the evaluation of cultures is thus an objective one. The measurements can be expressed in mathematical terms. The goal—security and survival—is likewise objective; it is the one that all species, man included, live by. Thus we are able to speak of cultural progress objectively and in a manner which enriches our understanding of the culture history of mankind tremendously. And finally, we can evaluate cultures and arrange them in a series from lower to higher. (White 1947: 187)

What gave White's evolution its distinctive form was his belief that change could occur in only two ways: either humans improve the efficiency of old tools or they invent new tools. Evolution via the former is restricted, however, as exemplified in White's (1943: 343) statement that the "extent to which man may harness natural forces [energy] in animal husbandry is limited" and his later statement (White 1959b: 369) that "some progress can of course be made by increasing the efficiency of the technological means of putting energy to work, but there is a limit to the extent of cultural advance on this basis." This is merely an expression of **orthogenetic evolution**—that is, evolution governed by laws and passing through a predetermined sequence of stages.

Cultural evolutionism, then, is concerned with generalities of process and change—cross-cultural regularities, or "laws"; this feature made it scientific in the minds of White and Steward. It also made it scientific in the minds of archaeologists in the 1960s and early 1970s—a time during which a so-called "new" archaeology—*processualism*—was born. The leading architect of a scientific archaeology based on anthropological concepts, most of which center around the notion of culture, was Lewis Binford. He was clear on his objectives:

> Specific "historical" explanations . . . simply explicate the mechanisms of cultural process. They add nothing to the explanation of the processes of cultural change and evolution. If migrations can be shown to have taken place, then this explication presents an explanatory problem: what adaptive circumstances, evolutionary processes, induced the migration. . . . We must seek the explanation in systemic terms for classes of historical events. (Binford 1962: 218)

Binford was influenced by the cultural evolutionists of the mid-twentieth century, especially White, whose arguments

> became clear, logical vignettes. Culture was not some ethereal force, it was a material system of interrelated parts understandable as an organization that could be recovered from the past. . . . We were searching for laws. Laws are timeless and spaceless; they must be equally valid for the ethnographic data as well as the archaeological data. (Binford 1972: 8)

For the new archaeologists, laws were regularities, confirmed hypotheses, or at the very least, things to be discovered. Hence, Patty Jo Watson, Steven LeBlanc, and Charles Redman (1984: 5–6) made the following claim:

> science *is* based on the working assumption or belief by scientists that past and present regularities *are* pertinent to future events and that under similar circumstances similar phenomena will behave in the future as they have in the past and do in the present. This practical assumption of the regularity or conformity of nature is the necessary foundation for all scientific work. Scientific descriptions,

explanations, and predictions all utilize lawlike generalizations hypothesized on the presumption that natural phenomena are orderly.

Thus, by understanding something about the present, one could access the past—a stance that fit neatly with Whitean evolution, as it had with the earlier formulations of Tylor (1871) and Morgan (1877). With a few exceptions, the processualists were never clear on how or from where the laws were supposed to be derived, and the general result was a conflation of laws with empirical generalizations; hence cause was rendered in commonsense terms.

Processualists (e.g., Spencer 1997) have pointed out that whereas Darwinian evolutionary theory is capable of explaining the genetically dictated behaviors of non-human organisms, it is not applicable to the study of humans because it does not take into account the role of intention or motivation in causing human behavior. Such a statement immediately sets humans apart from other animals in terms of what is and is not subject to selection. Our answer is that whereas human intent might play a *proximal* role in deciding which among several variants actually gets selected (in the sense of being "chosen"), it plays no ultimate role. As David Rindos (1984: 4) argued, "Man may indeed select, but he cannot direct the variation from which he must select." Alexander Alland (1972: 228) made a similar argument: "Individuals do not have to know why a certain act is adaptive for it to be adaptive. They don't even have to know that they are performing certain repetitive acts for those acts to alter [their] survival capacity."

Perusal of the archaeological and anthropological literature makes it clear that most researchers believe that when it comes to humans there are indeed two kinds of evolution—one biological and one cultural—and that different theory is needed for each. For the biological side of the house, Darwinian evolutionism is appropriate for deriving causal statements; for the cultural side, a decidedly Spencerian, or Whitean, approach is appropriate.

That Spencerian and Darwinian evolution are dissimilar is clear. Americanist archaeologists and cultural anthropologists of the early twentieth century appear to have recognized at least some of the differences between the two, but they were insufficiently knowledgeable about Darwinism to figure out how to use it. Darwinism simply had little to offer anthropology and archaeology because cultural evolution is reticulate—its branches grow back on themselves—whereas biological evolution branches outward continuously. Cultural evolution does not involve the transmission of genes, whereas biological evolution does; and people are not subject to the forces of natural selection and can intentionally direct the evolution of their cultures, whereas biological evolution depends on the natural selection of nondirected mutations.

Discomfort with the removal of human behavior—at least those aspects deemed to be under the control of culture—from the Darwinian evolutionary process was evident as early as the 1930s, although those voicing discomfort were in a minority:

> Archaeologists, noting that modern biology has mounted above the plane of pure taxonomy [that is, classification], have attempted to follow that science into the more alluring fields of philosophic interpretation, forgetting that the conclusions of the biologist are based on the sound foundation of scientifically marshalled facts gathered during the past century by an army of painstaking observers. This groundwork we utterly fail to possess. Nor will it be easy for us to lay, because the products of human hands, being unregulated by the more rigid genetic laws which control the development of animals and plants, are infinitely variable. But that is no reason for evading the attempt. It has got eventually to be done, and the sooner we roll up our sleeves and begin comparative studies of axes and arrowheads and bone tools, make classifications, prepare accurate descriptions, draw distribution maps and, in general, persuade ourselves to do a vast deal of painstaking, unspectacular work, the sooner shall we be in position to approach the problems of cultural evolution, the solving of which is, I take it, our ultimate goal. (Kidder 1932: 8)

A. V. 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. It was this lack of a basic theory that led to Robert Dunnell's (1978, 1980) seminal articles on how to apply Darwinian principles to an examination of the archaeological record. The premise underlying Darwinian evolutionary archaeology is that objects occurring in the archaeological record were parts of human **phenotypes**—the physical expressions of organisms—in the same way that bones and skin are. Thus those objects were shaped by the same evolutionary processes as were the bodily features of their makers and users. This is a shorthand way of saying that the possessors of the objects were acted on by evolutionary processes. Under this perspective, evolution is viewed as the differential persistence of discrete variants, regardless of the scale of "variant" being defined.

Evolutionary archaeology involves measuring variation—that is, dividing it into discrete sets of specimens (**groups**) using **ideational units** (conceptual entities, or classes) derived from whatever theory one is working under; tracking variants through time and across space to produce a historical narrative about lineages of particular variants; and explaining the differential persistence of individual variants comprising lineages in particular time-space contexts (Lyman and O'Brien 1998, 2000; O'Brien and Lyman 2000). Evolutionary archaeology has numerous parallels to modern paleobiology. It is geared toward providing Darwinian-like explanations of the archaeological record, just as paleobiologists explain the paleontological record. There are two steps: the construction of cultural lineages and the construction of explanations for those lineages being the way they are (Szalay and Bock 1991). Both steps employ concepts embedded within Darwinian evolutionary theory, such as natural selection (a process of change), a transmission mechanism (which itself is a source of new variants), invention and innovation (other sources of new variants), and heritability (O'Brien and Lyman 2000).

We point out that despite our view of what evolutionary archaeology is and how it provides explanations, there is considerable debate in the discipline over the applicability of Darwinian evolutionism to an examination of the archaeological record. There are those who view it as reductionistic (e.g., Maschner 1998) or as narrow empiricism (e.g., Watson 1986), as well as those who argue that the proper role of Darwinian evolutionism in an archaeological context is as a framework for the study of function (e.g., Boone and Smith 1998). This perspective, referred to as **evolutionary ecology**, views evolution in terms of how it engineers a better product—a perspective that actually is complementary to our characterization of evolutionary archaeology and not a polar opposite (O'Brien et al. 1998; O'Brien and Lyman 2000). The difference between evolutionary archaeology and evolutionary ecology is where each views ultimate cause as being lodged. Evolutionary ecology leads to the identification of near-term, or proximate, causes, whereas evolutionary archaeology addresses long-term, or ultimate, cause. Evolutionary ecology seeks to know how things work now; evolutionary archaeology seeks to know why things came to work the way they did in particular time-space frameworks (Lyman and O'Brien 1998).

## CASE STUDIES

It would be difficult to find another topic in Americanist archaeology that has spawned more discussion, speculation, and models than the question of where, when, how, and particularly, *why* agricultural systems arose. Agriculture, together with its attendant features and processes, has been viewed as a result of both deliberate human action and the impetus for various human responses to a changing environment. By focusing briefly on the work of Kent Flannery and David Rindos we can examine two contrasting positions—Flannery's cultural ecology and Rindos' Darwinian evolutionism—on the issue of agricultural origins. By emphasizing the systemic nature of human–plant interactions, Flannery bypassed many of the contentious issues that have long characterized discussions of agricultural origins, especially the role of population growth in effecting new patterns of subsistence. Important to Flannery's models is the proposition that for long periods of time humans and nature were in harmonic balance maintained by negative feedbacks that damped change. When the environment (cultural and/or physical) changed, even if those changes were minor, humans made appropriate adjustments to keep up with the changes.

Flannery recognized a long preagricultural phase of human–plant interaction that preadapted humans for the more intensive interactions that followed, although in the background of his models are two important inputs—environmental change and population growth—that cause the initial kick to the system; that is, they cause the "minor deviations" (Flannery 1968: 65) that eventually cause wholesale change in the cultural system. Adaptation thus becomes the inevitable result of environmental change, with human intent lurking in the background: "It is possible . . . that cultivation began as an attempt to produce artificially" stands of plants in the same densities as those produced naturally (Flannery 1968: 89). Why, we might ask, would human groups intentionally modify their environment? The answer, according to Flannery, is because of environmental perturbations that had upset the previous balance humans had established with nature—perturbations in the form of climatic change, population growth, or a host of other factors. All of those can be identified as potential "causes" of agriculture.

There is a way of looking at the origins of agriculture that does not lodge cause in human intent and need, and it was offered by Rindos (1984), who noted that domestication occurs *before* the origin and development of agricultural systems; it is not the *reason* agricultural systems develop. In other words, in a domesticatory environment human behaviors evolve in concert with those of the plants. Agricultural systems actually "evolve" as a result of this mutualism, which is mediated by environmental manipulation. Why, Rindos asked, when there are so many examples in nature of non-human, mutualistic domesticatory systems—ants and acacias, squirrels and oak trees, for example—do we afford human–plant agriculture a special place conceptually and methodologically? Why should we view the coevolutionary relations that humans and plants have developed over thousands of years any differently than we do the mutualistically reinforced behaviors of other animals and their plants? We suspect that we do it for the simple reason that human informants can tell anthropologists why they did (or might do) something. Ants and squirrels, however, cannot tell us.

Rindos emphasized that there are modes of domestication that occur throughout the domesticatory process, each of which is mediated by different kinds of human behavior and occurs in different environments. The first of these is *incidental domestication*, which is the product of nonpurposeful dispersal and protection of wild plants by humans. Over time the developing relationship selects for morphological changes in plants, thus preadapting them for further domestication. There is nothing "agricultural" about the environment in which this relationship takes place, and hence the niche breadth of the incidental domesticate is determined by the environment and the exploitive techniques of the human groups. The human–plant relationship is conservative and reinforces negative feedbacks that maintain the existing exploitive strategies rather than creating positive feedbacks that change the system, as in Flannery's scenario. Yields rarely change, which places limits on the size of the groups that the plant population can support.

*Specialized domestication* involves an intensification of tendencies present under incidental domestication. Humans, instead of being simply opportunistic agents, now become obligate agents for the plants, which enhances the success of the plants while simultaneously changing the basis of human subsistence strategies. The origin of these behaviors can be found in selective pressures on both humans and plants as incidental relationships intensify. If these co-evolutionary relationships are successful, they may lead to increasingly specialized relationships. Rindos saw several effects of this ever-increasing interaction. First, human dependence on plants may increase to the point that human success is dependent on the success of the plants, which in turn may depend on humans for their survival at higher densities in new locales. Second, the plants no longer are limited by previous environmental restrictions as their realized niche expands through such mechanisms as weeding, watering, and burning. Third, as the co-evolving plants increase their productivity, the potential for human population growth increases.

*Agricultural domestication* is the culmination of these increasingly obligate relationships and is mediated by specific human behaviors—seed selection and storage, along with all the behaviors at work previously—as well as by evolutionary tendencies embedded in the developing agroecology. Hence, agricultural domestication is closest in concept to what typically is thought of in anthropology simply as "domestication," although it differs substantially in that it is actually a culmination of a long process of plant–human mutualism as opposed to being a "thing" that arose to replace previous food-getting behaviors.

Rindos' model of domestication does not rely on human intent, need, or any other orthogenetic "cause." Rather, cause is found in the increasing mutualism between humans and plants and the selective advantages it brings about; thus it is external to the system under investigation. If one invokes intent and/or need as the cause of domestication, one could pose the question, "Why haven't *all* societies adopted agriculture?" (Pryor 1986: 889). Economist Frederick Pryor, noting that "the origins of agriculture have been left too long to the archeologists" (p. 892), scanned the standard cross-cultural sample of 186 precapitalist societies (Murdock and White 1969) to determine which groups were agricultural and which were not. He then scaled each group in terms of the importance of agriculture, using values from 0 (agriculture absent) to 4 (agriculture very important). Pryor could "explain" away the absence of agriculture among 35 of the 38 groups who scored lowest on the scale, but he had problems with three North

American groups—the Pomo, the Micmac, and the Northern Paiute. After reviewing the technological and economic basis of those groups, he noted that "by all conventional reasons, the Pomo and Paiute (and, with less certainty, the Micmac) *should* have adopted some type of agriculture" (Pryor 1986: 891). The answer, according to Pryor, to why the Paiute should have adopted agriculture is that although they lived in regions of low rainfall, they had easy access to irrigation water in the form of streams and lakes.

As O'Brien and Wilson (1988) pointed out in rebuttal to Pryor, the Northern Paiute (specifically, the Wadadika "band" of the Northern Paiute) *did* develop a highly specialized agroecology—one that involved intensive interaction with a variety of plants. The Wadadika burned tobacco fields and seed fields and stored seeds for planting, but Pryor is correct; the Wadadika did not irrigate their fields. But is this evidence that they were not plant domesticators? No, they *were* plant domesticators, but they had not developed the intensive relationships that Rindos terms "agricultural domestication." To declare that they therefore were not agricultural ignores the evolutionary nature of the domesticatory process and forces the investigator to decide that the "cause" for the lack of agriculture was because the "need" for it was not great enough.

## FUTURE IMPORTANCE

It is our impression that the majority of Americanist archaeologists working today would consider themselves, if loosely, processual archaeologists. Thus, much of the effort to identify cause in the archaeological record will, we suspect, follow the tenets of this paradigm. It is worthwhile, then, to briefly review those tenets and where we suspect they will lead the discipline.

Binford (1962: 224) noted in the early 1960s that

> Archaeologists should be among the best qualified to study and directly test hypotheses concerning the process of evolutionary change, particularly processes of change that are relatively slow, or hypotheses that postulate temporal-processual priorities as regards total cultural systems. The lack of theoretical concern and rather naïve attempts at explanation which archaeologists currently advance must be modified.

Prior to the time Binford's article was published, there had been little more than occasional grumbling among rank-and-file archaeologists about the lack of "explanation" of the archaeological record. We suspect this was because practitioners were unsure of how to build explanations. Binford's 1962 paper and several more he published over the next five years provided an algorithm.

The algorithm was attractive in its simplicity and it comprised three steps. First, discard the notion of a cultural lineage as a flowing stream of ideas that changed through time and varied over space and replace it with the notion that culture is humankind's **extrasomatic**—non-biological—means of adaptation. This required the second step—new classifications of archaeological materials—because the study of *culture* processes comprised the study of cause-and-effect relations among *cultural*—not archaeological—variables. The culture historian's artifact styles denoted group identity or ethnicity (Binford 1962: 220), and thus a different style might denote a different time period; here the focus was on **homologous** similarity—similarity that is the result of historical relationship. Artifact function was what was critical to the new **systematics** (study and sorting of the diversity of phenomena such that like goes with like), and here the focus was on **analogous** similarity—similarity that is the result of two or more organisms (or groups of organisms) finding similar solutions to similar problems confronting them. Artifact function could be *technomic*—the function of an object in technological situations; *sociotechnic*—the function of an object in social situations; and *ideotechnic*—the function of an object in ideological situations (Binford 1962). Focusing on the function of artifacts was in line with the definition of culture as humankind's extrasomatic means of adaptation. This focus was possible because in Binford's (1962: 219) view the "formal structure of artifact assemblages together with the between element contextual relationships should and do present a systematic and understandable picture of the *total extinct* cultural system."

Potential catalysts for processual change were sought "in systemic terms for classes of historical events such as migrations, establishment of 'contact' between areas previously isolated, etc." (Binford 1962: 218). The problem was one of answering the "why" questions. As we noted earlier, to answer such questions required, it was thought, the establishment of a set of general laws regarding how cultures changed, and which connected *causes* with their *effects*. Establishing the laws comprised the third step of the processual-archaeology protocol (see O'Brien and Lyman [2000] for more details).

The search for laws evident in the literature of the 1970s and early 1980s has slowed in the last fifteen years as processual archaeologists have adopted White's cultural evolutionism, albeit sometimes with bits and pieces borrowed from Darwin's theory of evolution. The net result has been the retention of human intent—often expressed as "directed variation"—thereby keeping cause lodged in the "conscious, purposive strategies that individuals and groups pursue in order to further their own interests" (Spencer 1997: 211). While not denying a role for human intent in the evolutionary history of cultural lineages, we perceive weaknesses in such a focus, the most serious one, as we noted earlier, being that cause is lodged within the phenomena to be explained (Lyman and O'Brien 1998).

The search for cause will continue to be the ultimate goal in science, no less in archaeology than in any other discipline that seeks explanations for the natural world being the way it is. Despite the fact that we often believe we can offer, through experience and common sense, explanations for why and how past humans did the things they did, there is no reason to believe that these explanations should be taken seriously from a scientific point of view. If, as we maintain, objects in the archaeological record are parts of previous phenotypes, then it is reasonable that those phenotypes were acted on by Darwinian evolutionary processes. Reliance on Darwinian evolutionism as a source of causal explanations precludes searching for ultimate cause among the phenomena being studied and places archaeology outside the reach of tautology.

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