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General Fitness, Transmission, and Human Behavioral Systems

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An important aspect of nonlinear systems, a perspective that is becoming increasingly prominent in natural and social sciences (Henrickson and McKelvey 2002), is that seemingly small-scale phenomena can sometimes have large-scale consequences. In this chapter I explore the larger effects of an apparently simple concept—fitness—on a Darwinian approach to human social dynamics. In one of the earliest treatments of the application of modern Darwinian theory to archaeological explanation, Dunnell (1980) notes that although the concepts of neo-Darwinian epistemology appear highly relevant for explaining social and cultural change, biological theory cannot be applied wholesale to human behavior; nor can archaeologists expect biologists to extend evolutionary theory to culture. Rather, social scientists—and archaeologists specifically, given their focus on the long-term record of social change—need to lead the way in creating the theoretical framework to apply Darwinian concepts to human behavioral systems.

In the years since Dunnell wrote that article, an increasing number of archaeologists have worked to develop a neo-Darwinian framework for explaining social change. There have been theoretical works dedicated to the ways in which major evolutionary concepts such as selection and adaptation, systematics and units, variation and transmission, and optimization and game theory can be applied to human social systems, along with examples of their application to foraging behaviors, the rise of agriculture, sharing and altruism, and social conflict (e.g., Boyd and Richerson 2005; Henrich et al. 2006; O'Brien and Lyman 2000b, 2003d; Rindos 1984; Shennan 2002a; Smith and Winterhalder 1992b; Winterhalder and Smith 2000). The majority of these works mention the concept of fitness, but there has been little examination of what it means

in a social context. I suggest that this has had a number of problematic consequences, especially with respect to understanding cultural transmission. Given a growing interest in evolutionary epistemology, generated by new research applying complex-systems perspectives to human society (e.g., Bankes 2002; Henrickson and McKelvey 2002), this is an appropriate time to explore ways in which fitness operates within a Darwinian theoretical framework for the social sciences. Here I outline an expanded concept of general fitness that incorporates biological, social, and other transmission processes.

THE CONCEPT OF FITNESS

Fitness is one of the fundamental concepts of evolutionary biology, providing the underlying rationale for the mechanism of Darwinian selection. In essence, the “fitness” of a trait is its propensity to affect, positively or negatively, the reproductive success of an organism. This in turn has consequences for the frequencies of the genes underlying the trait, its phenotypic expression in succeeding generations, and, over the long term, the genetic and phenotypic makeup of populations. Fitness is not an either/or proposition. A trait can have a positive (enhancing reproductive success) or negative (reducing reproductive success), strong or weak, or even neutral (having less effect on reproduction than stochastic processes) fitness coefficient.

As O'Brien and Holland (1992) point out, potential fitness—the capacity for a trait to positively or negatively affect reproductive success—is what drives Darwinian selection (see also Smith and Winterhalder 1992a). However, such propensity is difficult to measure *a priori*, so fitness coefficients are often calculated on a *posteriori* effects of a trait on reproductive success. The general, and usually reasonable, assumption is

that the actual reproductive success of individuals with a trait compared with individuals possessing an alternative trait (or alternate variants of a trait, to be more precise) approximates the relative potential fitness of the trait variants. In other words, if we consider a hypothetical trait for leg length in steppe ungulates, those with longer legs might be observed to have greater reproductive success than those with shorter legs, leading us to conclude that the trait variant for longer legs has a higher potential fitness value (coefficient) than the variant for shorter legs.

This brings up two other important considerations for the concept of fitness. First, all fitness is relative (O'Brien and Holland 1990), meaning that a trait's ability to enhance or reduce reproductive success is generally meaningful only in relation to the fitness of an alternate variant of the trait. Although it is possible for a trait variant to cause death or sterility, it would obviously disappear within a single generation. In the overwhelming majority of cases, then, individuals with all variants of a trait are reproductively successful, but some are more successful than others. Hence, it is the fitness of one variant relative to another that is important in Darwinian change. Second, fitness is also relative to the environmental context in which an individual lives and operates (Sober 1993). To continue with our hypothetical ungulate, longer legs may have higher fitness values than shorter legs on a steppe, where they can help an individual escape predation and, hence, reproduce more successfully. However, the reverse may be true in a mountainous environment, where shorter-limbed individuals are less likely to fall and be injured or killed. An important point here, given the objectives of this volume, is that the social context is as much a part of the environment as topography in terms of calculating the relative fitness of traits.

FITNESS AND DARWINIAN ARCHAEOLOGY

Given the importance of the concept of fitness to evolutionary biology, it would seem that fitness or an analogous concept should be equally critical to the application of Darwinian principles to human society. However, although fitness is commonly mentioned in this context, the specific manner in which it can be applied to human behavior has been little explored (Barton and Clark 1997a, 1997b). Rather, there remains considerable ambi-

guity about the role of fitness in Darwinian social change. This stems in part from the potentially complex interactions between biological and behavioral change. Cavalli-Sforza and Feldman (1981) and Boyd and Richerson (1985) began to model these complex interactions quantitatively over two decades ago, and similar work continues today (e.g., Boyd and Richerson 2005). More problematic, however, has been the manner in which biological change and social change have been linked theoretically.

There is widespread recognition among archaeologists applying Darwinian principles to social change that neo-Darwinian processes can be applied independently of any direct causal connection with human biology. That is, there is no need for a "strong sociobiological thesis" (Kelly 1995; Wilson 1975, 1978) that requires a genetic basis for complex human behaviors in order to employ neo-Darwinian principles. Nevertheless, many evolutionary anthropologists have used the concept of fitness as a link between the differential persistence of human social behaviors and successful biological reproduction. Such linkage is understandable because the idea of fitness is so deeply embedded in the epistemology of biological evolution, popularized in the nineteenth century by Spencer's (1864) famous phrase "survival of the fittest." For anyone familiar with biology, it is difficult to imagine selection without fitness or fitness without biological reproduction. Further, even in today's industrialized, urban world, considerable social learning takes place in the context of the biological family. This was even more so in small-scale prehistoric societies. Hence, biological reproduction has had strong effects on opportunities for social learning, even if the behavioral variants learned have no direct genetic bases.

Thus, even among some of the most articulate proponents of using a Darwinian approach to examine social change, the process of selection in human societies has been consistently tied to biological reproductive success. For example, Dunnell states that

if a given trait is heritable to a measurable degree (the mechanism of inheritance need not be known), and if it also affects the fitness of organisms possessing the trait to some measurable degree (recognizing the possibility of neutral or stylistic traits), then

the trait must be subject to natural selection and will be fixed in populations in accord with the biological model. [1980:63]¹

Similarly, Rindos lays out how culture can operate as an inheritance system following Darwinian rules and yet be free of genetic constraints, but he also notes that

cultural behaviors may have some influence, no matter how small, on human survival and reproductive success in a cultural setting. Hence, changes in one trait may, either directly or through the new suite of traits to which they contribute, affect the fitness of individuals in that setting. [1989b:13]

Leonard and Jones offer an alternative perspective, noting the differences between cultural and biological transmission: “Not only do the modes of transmission and the traits transmitted differ between biological and cultural systems, but changes in the latter may occur more rapidly than generation time and without any necessary expression in or ultimate effect, on, the gene pool” (1987:212). They propose the concept of “replicative success” for human behavior: “It is important to recognize when dealing with the components of cultural systems that the differential persistence of variation is not accomplished solely through differential reproductive success but also through differential *replicative* success of traits themselves” (1987:212). Further, “the replicative success of a particular trait might or might not affect the reproductive success of the bearer. Those that do can be considered functional, and those traits with no selective import termed stylistic or neutral” (Leonard and Jones 1987:214).

Commenting on Leonard and Jones, O’Brien and Holland note that

replicative success depends simply on an increase in frequency of the trait over time. In terms of reproductive success, possession of a trait may make individuals more fit by giving them a selective advantage over individuals not possessing the trait. But if possessing that trait has no effect on the reproductive success of the possessor, then the trait is neutral. [1990:50]

O’Brien and Holland are clear about how they

view fitness in the biological sense but less clear about the link between selection for behavioral variants and fitness:

Variation as seen in the archaeological record does not necessarily pass through the phenotype–genotype–phenotype process. This in no sense precludes a focus on selection from an archaeological perspective if we accept the premise that things viewed in the archaeological record were part of past human phenotypes. [1990:35]

They continue:

Selection operates on humans as it does on all other organisms, and the presence of certain features may give some humans increased fitness relative to other humans. And, as with other organisms, the presence of certain features among humans may confer no increase in fitness, i.e., features that are neutral relative to reproductive success. But to compound the analytical problem, when we deal with humans we must confront the phenomena of social reproduction and social success, which, though perhaps linked to biological reproduction and reproductive success, are not the same. [1990:35]

However, they subsequently ask if “features that are evident in the archaeological record [are] capable of providing insights into the reproductive success of their bearers” (1990:35).

In a slightly later article on adaptation, O’Brien and Holland (1992) maintain the linkage of reproductive success → fitness → selection → adaptation, although they still seem ambiguous with respect to the role of biological reproduction. Whereas they differentiate between realized and potential fitness, they tie both to reproductive success. In discussing the origin of traits that are adaptations, they note that “selection, by means of differential reproduction, in essence ‘created’ the trait” (1992:42). Then, when discussing an example of ceramic change in the eastern United States that they claim was the result of selection, they point out that it was accompanied by an increase in fertility (reproductive success [see also O’Brien and Holland 1995]).

Smith and Winterhalder (1992a) make the same kind of linkage among reproductive success, fitness, and selection in a human behavioral context, although they operationalize them somewhat

differently for human behavioral ecology. They point out that important aspects of human behavior are “due to culturally acquired information” and that such behaviors are “heritable if faithfully transmitted to offspring, even by nongenetic means” (1992a:26). However, they go on to state that “fitness differences must also exist if natural selection is to occur” (1992a:26). In their discussion of fitness, they clearly envision the concept as embodying reproductive success, although like O’Brien and Holland (1992) they favor the use of potential fitness over realized fitness. Hence, although evolutionary ecologists such as Smith and Winterhalder generally focus on the immediate socioeconomic costs and benefits of human behavioral variants, they see the propensity to make decisions that increase utility or other currency as a long-term result of selection that increases human fitness (reproductive success [see also Shennan 2002a; Winterhalder and Smith 2000]).

The point here is not to criticize these authors but, rather, to show that even among the leading proponents of a Darwinian approach, reliance on a simple biological definition of fitness has been problematic. It has led to apparently contradictory statements, on the one hand, emphasizing that human behavioral change should be explainable in a Darwinian framework without recourse to genetic transmission of behavioral traits while, on the other hand, relying on the criterion of biological reproductive success as the ultimate driver of Darwinian selection. Insisting, even if reluctantly, that fitness means reproductive success (potential or actual) and that selection results from fitness differentials has made it difficult to argue the case that selection affects human behavioral systems independent of genetics. It also has led to a mistaken belief among many social scientists with only a superficial understanding of modern evolutionary theory that proponents of a Darwinian approach are but thinly disguised sociobiologists to whom human behavior is reduced to genetics.

In addition to ambiguity over the contribution of genetics and culture to social change, there are at least two other conceptual difficulties that arise when applying a purely biological definition of fitness to human behavior. One has to do with genetics, and the other, with time. With respect to genetics, fitness in biological systems mediates the feedback loops between the genotype and phenotype. That is, if one of the phenotypic

effects of a trait is to increase the reproductive success of the individual who bears it, then that same reproductive success will increase the frequency of the genotype responsible for the trait. Such a change in gene frequency is the only way in which natural selection generates biological evolution. Assuming that human behavioral traits are transmitted through nongenetic means, how can an effect of increased reproductive success, which is a phenotypic proxy for the replication of genetic material and its transmission to another individual, result in an increased representation of that behavior? Given a purely biological definition of fitness, logically there is no connection between the effects of the behavior and its representation among a population of humans. Of course, in situations where a behavior is socially passed on in a family setting, reproductive success would favor such transmission, but such success would not be causally related to behavioral change the way it is in the genetic case.

With respect to the conceptual difficulties involving time, humans are long lived and have relatively few offspring per set of parents. Differential reproductive success can result in evolutionary change in humans, but in generational times it will tend to be much slower than many of the behavioral changes of interest to archaeologists. Furthermore, if we have learned anything from the models of cultural transmission that have been proposed and used over the past two decades (e.g., Bettinger and Richerson 1997; Boyd and Richerson 1985, 2005; Richerson and Boyd 2005; Stoltis et al. 1995), it is that the varied forms of social learning on which reproductive success has minimal impact can significantly alter behavioral frequencies in selection-like ways over very short time periods.

Not all evolutionary archaeologists embrace a strictly biological definition of fitness for human society. Neff, for example, relies on cultural transmission as the basis for fitness: “‘Ceramic fitness’ in [pottery-making] societies must entail differentials in the success of individuals at communicating their pottery-making knowledge in one-to-one interaction” (1992:158). He goes on to state that “selection affects the information content of ceramic traditions, thereby shaping ceramic evolution, by interfering with the interindividual transmission through history of information about making pots” (1992:160). Likewise, Clark and I (Barton and Clark 1997ba)

suggest that information transmission, rather than reproductive success, is a more appropriate basis for fitness in human behavioral systems. We note that “many human behaviors do not have even the partial genetic basis known to exist for language. This suggests that the reproductive standard, as it is now conceptualized, may be an inappropriate fitness measure for human behavior” (1997b:12). We go on to propose that it might be more useful to

treat the transmission of *information* responsible for behavior as the critical variable, rather than the mechanism by which it is transmitted. . . . In other words, fitness should be defined and measured in terms of successful information transmission—both potential and realized—rather than reproduction (or even “replication” sensu Leonard and Jones [1987]). [1997b:13]

GENERAL FITNESS

A useful first step in taking a fresh look at the concept of fitness as it relates to human behavior and social systems, specifically the transmission of traits within these systems, is to deconstruct the original concept of biological fitness. If we follow the majority of the proponents of a Darwinian approach to social change, fitness is the propensity for a trait to increase (or decrease) the reproductive success of the individual bearing that trait. By trait we mean some aspect of an individual’s total phenotype that we have analytically differentiated for study. A trait may, and generally does, have effects other than reproductive success, but its effects on reproduction are the critical ones for fitness. It is some real-world consequence of the trait that affects reproductive success; in most cases this consequence involves the interaction of an individual with his or her environmental context. In other words, a trait has an impact on the manner in which an individual acquires food, escapes predation, or achieves social status. For example, the long legs of our hypothetical steppe ungulate allow it to run faster, to see above tall grass, and to nurse its young while they are standing. Reproductive success is an essential component of fitness and its link with selection because it affects the future frequency of a trait. No matter how large its fitness value, a trait is never replicated in an offspring. Rather, the genetic information that codes for the trait is

replicated. A phenotypic trait is the real-world expression of a gene. If one of the consequences of this expression is an increase in reproductive success, it is, in fact, increasing the chances that the gene that codes for the trait, not the trait itself, will be transmitted to another individual. Put slightly differently, fitness is the propensity for the real-world expression of genetic information to affect the interaction of an individual and his or her environment such that it also affects the probability that the genetic information—a copy of the relevant portion of an individual’s DNA—is transmitted to his or her offspring.

What happens to this definition of fitness if we allow for information that codes for a phenotypic trait but is neither stored nor transmitted genetically? The position not only of the previously cited proponents of Darwinian explanations for social change but of most social scientists is that much, possibly most, of the human behavior that we study is transmitted primarily or entirely transmitted by social rather than genetic means. If we take culture in the anthropological sense to be the system of knowledge and beliefs—more generally information—that underlies the expressed behaviors of individual members of a society (Richerson and Boyd 2005), then we can simply rephrase the above abstract fitness definition as follows: Fitness is the propensity for the real-world expression of cultural information to affect the interaction of an individual and his or her environment such that it also affects the probability that the cultural information is transmitted to another individual. Because transmission is non-genetic, transmission to an offspring is not required, although it may be common (Dawkins 1990; Dennett 1995).

Combining the concepts that underlie both the biological and cultural definitions of fitness, we can abstract to a more general level that includes both. Fitness at this level is the propensity for the manner in which an entity interacts with its environment to affect the transmission to other entities of the information governing that interaction.

“General fitness,” then, is a concept that can be applied to a class of systems characterized by certain properties:

- A system must comprise individual entities.
- Each individual entity must embody information that governs the way that entity interacts with its environment, including other entities. This can include both physical

structure and behavior.

- This information can be transmitted and received from one entity to another, and there is variation among entities with respect to their capacity for information transmission (how much is transmitted, information fidelity, and so on).
- The manner in which an entity interacts with its environment may affect the success with which this information can be transmitted from one individual to another (for similar requirements for natural selection to occur within cultural systems, see Richerson and Boyd 2005).

Seen in this light, general fitness is a property of complex cybernetic (information-passing) systems, leading to their adaptive behavior (Bentley 2003). Within such systems, the concept of general fitness can be expressed in forms specific to DNA-based biological systems, human sociocultural systems, and other systems with the requisite properties, such as the cyberworlds of agent-based models.

DISCUSSION

What impact does such a definition of fitness have on a Darwinian approach to human social change? First, it eliminates apparent contradictions between asserting the importance of the nongenetic transmission of cultural information and its resultant behavior and the mechanisms of natural selection. If selection is a result of differential fitness among variants of a behavioral trait, and if fitness is measured by successful information transmission, then selection can occur in any case where one effect of a behavioral trait is to increase or decrease its chances of being transmitted to others. Reproductive success may be involved but is not required. From this perspective, it is much easier to discuss the role of selection in social change, especially change that happens within a generation or over a few generations, and evaluate its causes and consequences. This is generally the time scale for social dynamics that are of greatest interest to archaeologists and other social scientists.

For example, within human behavioral ecology a broader concept of fitness suggests that people tend to maximize economic benefit/cost ratios not because they have an ultimate genetic predisposition to do so but because those who enjoy economic and social success from such optimizing

behaviors are generally more likely to transmit the cultural information underlying their practices. Although increased reproductive success may accrue to those who practice more optimal economic behaviors, the greatest general fitness benefit is having more surviving children who can be indoctrinated with these behaviors—and perhaps having a surplus with which to support and teach the children of another family. Similarly, a general fitness concept helps to explain how evolutionarily stable strategies can evolve in less than a generation among human societies (Smith and Winterhalder 1992a).

There are additional potential implications for adopting this broader definition of general fitness. One is a better understanding of what appear to be “maladaptations”—features that “reduce the survival chances of a system” (Rappaport 1978: 58). It is difficult to explain how maladaptations could spread if selection always favors the most reproductively successful traits. However, if the fitness of a behavioral trait affects its chances of being replicated by any means, then it becomes easier to understand how a trait that is copied because it increases prestige, for example, can spread even if it reduces overall reproductive success. That is, when prestige is signaled by costly displays that require the expenditure of subsistence resources and take away from procreation, and the most prestigious individuals also serve as prominent role models for others, thus enhancing the chances for replicating this behavior, cycles of such social “arms races” can escalate to the detriment of the biological success of the participants. Richerson and Boyd (2005) offer an excellent discussion of how such apparent maladaptations can occur where social learning, not biological reproduction, is the most important process responsible for trait transmission (see also Henrich 2004, 2006).

Given the broader definition of general fitness, however, are traits that engender prestige arms races in fact maladaptive? If one effect of a trait is to enhance the chance that it will be passed on, is it not adaptive (it increases “adaptedness” [O’Brien and Holland 1992]), keeping in mind that adaptive may not necessarily be desirable by prevailing social standards? Here it may be helpful to return to an important aspect of the biological definition for fitness, in which a trait is measured by its effect on the reproductive success of an individual. Hence, we could evaluate general fit-

ness in terms of the consequences for an individual to transmit information that codes for his or her behaviors. "Cultural reproduction" could serve here as a useful shorthand phrase for the transmission of information that codes for social behavior among humans (for a discussion of social reproduction and success, see O'Brien and Holland 1990). That is, a particular trait may spread rapidly, but if it lowers the chance for overall successful cultural reproduction for an individual that possesses it, it is difficult to consider the trait an adaptation. Similarly, if it lowers the chances that the system of knowledge and beliefs responsible for the practices of a social group of humans (successful cultural reproduction at the population level) can be successfully passed to others, it would probably not be viewed as adaptive. This would include circumstances where cultural information is successfully transmitted but leads to the ultimate social or biological demise of a population.

To some extent, it may appear simpler to assess fitness in purely biological systems, where the information coding for phenotypes comes as a package during reproduction, than in cultural systems, where information responsible for behavior is transmitted differentially over an individual's lifetime (children learn different kinds of skills from different individuals as they grow and develop). However, it is not actually such a simple case in biology either, where meiosis, independent assortment, recombination, and crossovers affect the chance that a particular allele is transmitted to an offspring and a series of unique offspring are produced over the reproductive life of an organism.

Related to maladaptions, a general-fitness concept also may lead to better models for social collapse and resilience (e.g., Diamond 2005). Collapse is widely viewed as the inability of a system to maintain itself at a given level of size and complexity, causing it to disintegrate into a number of smaller, less complex subsystems. As in the case of prestige arms races, social hierarchies of incipient social complexity offer an individual at the top of a hierarchy an opportunity to greatly improve his or her cultural reproduction. As individuals maximize their general fitness—the result of selection favoring those who do over those who do not—the increased efficiency with which social hierarchies disseminate hierarchy-building behavior would cause these organizational structures to

proliferate and grow, at an increasing cost in resources, labor, coercion, and so on. Hence, once small-scale social hierarchies offer improved opportunities for cultural reproduction, selection would favor growth and expansion of complex societies. But there would be no general-fitness benefits to individuals that reduce or simply maintain the size and complexity of social hierarchies over those that increase them, with a consequence of runaway growth that eventually exceeds available resources and is checked by Malthusian processes that lead to collapse. The only limit would be when physical restrictions on information transmission make it impossible to increase cultural reproductive success with increasing hierarchy size. As information technology has improved over time, with the appearance of writing systems, wheeled and water transportation, mass printing, and electronic and digital information systems, this limit has been lifted, with consequent effects on selective pressures for social growth.

Beyond human society, a broader concept of general fitness that focuses on information transfer rather than on genetics alone may also have implications for animal behavior. Although kin selection and inclusive fitness work well for social insects, where most individuals are siblings and only one or a few reproduce (Hamilton 1972), they are more complicated to apply in, say, the higher vertebrates, where there are few siblings within a family, all or most members have reproductive potential, and considerable behavioral information is transmitted nongenetically, especially in social contexts (e.g., Beecher and Burt 2004). In such circumstances, apparent altruism, for example, could be viewed as an efficient means of creating increased opportunities for an individual to transmit behavioral information beyond restricted descent lines and to gain from nonparental individuals information that raises its own general-fitness level (Emlen et al. 1995). In both instances explanations that include successful cultural reproduction may be more parsimonious and robust than those that focus on successful genetic transmission alone.

Finally, adopting a general-fitness concept could help make Darwinian theory more acceptable and more understandable to many archaeologists. Because of their focus on the human past and the generally low temporal and behavioral resolution of the archaeological record, archaeologists cannot help but be aware of the evolutionary

dynamics of human society. Despite the waxing and waning of postmodern and poststructural movements within cultural anthropology, archaeologists remain largely (even if seemingly *de facto*) positivist; they tend to employ evolutionary paradigms of some sort; and they regularly use at least some Darwinian concepts (Barton and Clark 1997ab; Hegmon 2003). Nevertheless, there is considerable misunderstanding of and resistance to Darwinian approaches to social change. On the one hand, this results from a continued association between Darwinian theory and Spencerian progressivist evolution (Barton and Clark 1997ab). On the other hand, continued recourse to a reproductive standard for fitness, and hence for selection more broadly, leads many archaeologists to assume that Darwinian theory is thinly disguised sociobiology and environmental/genetic determinism. The conceptual link between Darwin and Spencer was forged in the social sciences over a century ago and has been difficult to break (Dunnell 1980; Lyman and O'Brien 1997), but a better understanding of actual Darwinian processes will go a long way in easing the grip. Refuting claims of genetic determinism would be considerably easier if Darwinian archaeologists adopted a general-fitness standard that gives equal or greater weight to cultural versus biological reproduction in explaining the differential persistence of behavioral traits. A better understanding of the operation of Darwinian algorithms (Dennett 1995) by the archaeological community would serve to generate a broader, more informed discussion about the domains of social dynamics where they are most applicable.

While disavowing Darwinian epistemology, many archaeologists continue to adopt Darwinian concepts under the rubrics of agency and practice theory (Hegmon 2003; VanPool and VanPool 1999; see ch. 16). One consequence is that archaeologists face a linguistic divide separating

them from other sciences that are wrestling with similar issues and applying similar concepts to understand the dynamics of complex adaptive systems. This is unfortunate because archaeology, and anthropology more broadly, is situated at the juncture of the social and natural sciences, with the potential to serve as the critical translator and integrator of both (van der Leeuw and Redman 2002). Although recent efforts aimed at semantic and theoretical concision (e.g., Barton et al. 2004; Hegmon 2003; Redman and Kinzig 2003) are beneficial, an inclusive Darwinian framework for complex-systems dynamics would be even more effective for furthering a new integrative science of socionatural systems.

In this sense, archaeology is poised to develop a more inclusive general evolutionary theory, as Leonard and Jones (1987) have proposed, that also would incorporate evolutionary psychology, evolutionary sociology, and biology. As Dunnell (1980) has noted, it is incumbent on archaeologists, not biologists, to develop Darwinian theory for the study of social change. And rather than developing theory that is understood only within our discipline, archaeology, with its control over the long-term record of human society where Darwinian epistemology is most applicable, can make a significant contribution to a unified theory of complex-systems dynamics (Bentley and Maschner 2003). Fitness plays a critical role in such a theory, conceptually mediating the interaction of entities and their environment with its consequences for the transmission of the information that governs that interaction. It is this recursive dynamic that drives evolutionary change.

NOTE

1. Dunnell later modified his stance, noting that “genetic transmission is not inherent in, nor essential to, evolutionary theory. It is but one empirical expression of trait transmission” (1989:41).