Origins in Archaeology

Evolutionary archaeology consists of three Darwinian approaches to archaeology: evolutionary ecology, selectionist archaeology, and behavioral archaeology. A succinct definition of evolutionary ecology is: “the application of natural selection theory to the study of adaptive design in behavior, morphology, and life history” (Winterhalter and Smith 1992: Bird and O’Connell 2006; Cane 2003). Human behavioral ecology is one face of evolutionary ecology that seeks to explain behavioral variability with regard to fitness-oriented goals (Broughton and O’Connell 1999). Though it lies within the framework of processualism due to the emphasis on process and long-term evolutionary trends, instead of adhering to the processual goal of explaining how change occurs, evolutionary archaeology shifts focus to addressing why changes in adaptation happen.

Behavioral ecology, which was originally established by ecologists in the 1960s and 1970s to study nonhuman animal foraging, investigates this problem based on optimality as an ultimate goal of human adaptation. Optimal foraging models are borrowed from ecologists and applied to human foragers in order to explore diversity in subsistence adaptations; these models must have a goal, currency, set of constraints, and a set of options (Kelly 1995). For behavioral ecologists employing optimal foraging models, gathering data from the archaeological record is not sufficient for explaining past human action. Instead, optimization models are applied with the assumption “that individuals will relate to their environment in ways that maximize their reproductive success” (Shennan 2005:60). These models are an investigative tool to explore hypotheses regarding human behavior and resource exploitation. For more on optimal foraging theory, see the website created by Lauren Willis.

Philosophical Foundation

Behavioral ecology is grounded in methodological individualism, which states the individual is an autonomous being who makes decisions based on optimizing their goals. This dovetails with the principle of natural selection, which usually acts on the individual “selection operates on variability within a population and favors individuals whose behavior enhances the opportunity to achieve goals” (Foley 1985, cited in Kelly 1995:53). Behavioral ecology thus makes the assumption individuals will act in a way that maximizes their fitness and that goals be defined, but not necessarily the same for all individuals.

Ontology

Behavioral ecology is concerned with studying the adaptedness of behavior by first reconstructing past behavior from the archaeological record and then accounting for this reconstruction using formal optimality models which “require hypotheses about a possible fitness-related goal for the behavior of interest, the alternate strategies to achieve that goal (including constraints that limit the field of possible strategies), the costs and benefits associated with each strategy, and the currencies in which those costs and benefits are to be measured” (Broughton and O’Connell 1999:153-4). When these variables are taken into account in a formal model, a prediction of an optimal pattern of behavior is configured. This can be used to explore adaptive change through time.

Intellectual Roots

The two main thinkers responsible for requisite theories pertaining to the development of behavioral ecology are Charles Darwin and Julian Steward. Darwin’s concept of natural selection stimulated scientists’ interest in adaptive change and diversity within species. Though Darwin struggled to apply natural selection to humans (due to a lack of knowledge regarding genetic transmission as well as paucity in the human fossil record in the late 1860s), evolutionary biologists readily employed the idea of natural selection to the ecology of animal and plant communities. Anthropologists and other social scientists eventually borrowed concepts honed by evolutionary biologists and ecologists and applied them to human societies both living and in the archaeological record. Behavioral ecology focuses on the ecological context of adaptation, and employs a model-based methodology capable of unleashing the power of Darwinism to analyze complex flexible phenotypes” (Winterhalter and Smith 1992:xv). In other words, due to Darwin’s theory of natural selection, behavioral ecologists can create hypotheses to explore diverse human adaptation.

Julian Steward developed cultural ecology in the 1950s, which is based on how human populations obtain energy from the environment in order to survive. "cultural ecology studies tied to account for cultural behaviors by showing how they were necessary to the act of getting food, or how..."
they improved foraging efficiency, reduced risk, or netted the highest returns (Kelly 1995:69). Though Steward did not incorporate a Darwinian evolutionary framework to his studies, two important concepts are his establishment of a materialist approach for studying behavior and a functionalist perspective wherein "environmental features are used as independent variables in the construction of adaptive or functional rationales for behavior" (Smith and Winterhalder 1981:2). Thus Steward's idea of cultural ecology helped build the foundation for behavioral ecology. For biographical information on current contributors to the field of behavioral ecology in the archaeology of hunter-gatherers, please see the Biographical Sketches section of the website.

Approaches to behavioral ecology in the archaeology of hunter-gatherers: three optimal foraging models

Optimal foraging models have been applied to investigate subsistence patterns of hunter-gatherers in the archaeological record. Optimal foraging models take decision making into account and "given a set of resources with specified characteristics (e.g., nutritional content, harvest and processing times), optimal foraging models propose how those resources will be used" (Kelly 1995:73). Also, these models assume the decision maker will want to make the optimizing choice. Three optimal foraging models particularly employed to the archaeology of hunter-gatherers are the prey choice model, the diet breadth model, and central-place foraging models.

The prey choice model is often utilized when trying to determine whether hunter-gatherers exploited a resource and, in some cases, to what extent (e.g., Waggoner and Surowell 2003; Byers and Ugan 2005; Surowell and Waggoner 2009). The prey choice model considers the rate of resources to determine whether a hunter-gatherer will choose to exploit a food item or continue foraging for a more preferred resource (Kaplan and Hill 1992; Kelly 1995). Return rates include not only the caloric (or other energy) value obtained from the resource, but also the cost of tracking, acquiring, and processing the food item. The maximal rate of net energy acquisition can be solved for by applying models that include the aforementioned variables, among others. It is assumed the food item with the highest return rate should be pursued, since this indicates optimized foraging.

The diet breadth model can also be used to investigate whether hunter-gatherers were specialists or generalists (e.g. Broughton 2002; Elston and Zeannah 2002). It is essentially a further investigation based on results from modeling prey choice. The number of resources calculated within the diet is the diet breadth. However, diet breadth is not just the range of resources exploited, but also their rank according to the maximal rate of return of each resource. Thus, a higher-ranked food item would (supposedly) comprise more of the diet, and therefore account for more of the diet breadth. Because of their association, the prey choice and diet breadth models can successfully be applied together, and often this is the case when attempting to reconstruct subsistence patterns of hunter-gatherers (e.g. Waggoner and Surowell 2003; Byers and Ugan 2005).

Central-place foraging models take into account the time it would take to travel to a resource and compares it to the net return rate of exploiting this resource. It rests on the assumption foragers return to a central place when they explore for resources (Kaplan and Hill 1992; Kelly 1995) and employs cost-benefit analysis to hypothesize where hunter-gatherers will make a residential base camp or food storage area. The application to central-place foraging can be useful for understanding human-gatherer settlement patterns with respect to resources, as well as for understanding changes to their diet and populations (e.g., Zeannah 2004; Kelly 2001). These models all have implications for greater knowledge of hunter-gatherer populations in the archaeological record, but Kelly (1995:100) cautions: "Foraging models do not claim to duplicate reality; instead, they claim to model reality at some level of specificity if hunter-gatherers are behaving according to a model's set of goals and conditions. Models can falsify expected behavior of hunter-gatherers if these behavior predictions are testable.

How is behavioral ecology applied to the archaeology of hunter-gatherers?

Since behavioral ecology was originally formulated to address behavioral adaptations of animals, applications to the archaeological record have presented challenges. Despite this, there are still revealing ways behavioral ecology is implemented to study past foragers. For example, ethnographic and ethnographical data can be used to testable hypotheses for the archaeological record that can be explored with optimal foraging models (e.g., Lewin 1984; Smith and Winterhalder 1981, Kelly 1995). Also, as clearly illustrated above, these models can be employed to study subsistence and settlement patterns and degrees of game specialization in past hunter-gatherers, as well as why these behaviors might change over time. Archaeologists using behavioral ecology into practice have mainly utilized zooarchaeological data (e.g., Broughton 2002; Elston and Zeannah 2002; Waggoner and Surowell 2003; Byers and Ugan 2005; Waggoner and Surowell 2009), but exploring evolutionary adaptations in lithic technology is another promising approach (e.g., Kelly 1988; Ugan et al. 2002; Surowell in press).

The works listed here are only a partial representation of how the archaeology of hunter-gatherers has benefited from the principles of human behavioral ecology. For a further discussion of these works, please see the annotated Bibliography section of the website.

Why might behavioral ecology be useful for studying hunter-gatherers in the archaeological record?

Behavioral ecology proposes a unique approach to studying past human behavior through the archaeological record. It provides human behavior as it can be deduced from models applied to
hypotheses formulated by investigating the archaeological record and ethnographic data. A behavioral ecology approach incorporates environment and ecology to understand human decisions, but by no means does this connote a subscription to environmental determinism. Since the majority of human history has been spent as hunter-gatherers, a diverse assemblage of behavioral adaptations is expected based on available resources, biological factors, and human choices (Lee 1968; Kelly 1995). This complexity cannot be sorted out or interpreted solely by examination of the archaeological record, which is why behavioral ecologists advocate using models to explore this range of variation in hunter-gatherer societies. More broadly, evolutionary ecology is applicable to many areas of study within human prehistory besides focusing on subsistence of hunter-gatherers; it has also been integrated into the study of hominin evolution, first colonizers of the New World, development of horticulture and agriculture, and social status in complex societies (see Broughon and Cannon, 2008). Ultimately, behavioral ecology is the best way to address research questions about hunter-gatherer archaeology because it is comprehensive, integrative, and testable (Broughon and O’Connell 1996:154). First, it is comprehensive because any time-energy related behavior can be plugged into formal models. Second, it encourages exploration of relationships between different behaviors. Finally, it can empirically test predictions based on hypotheses of optimal decision-making behaviors. These attributes make behavioral ecology indispensable to the archaeology of hunter-gatherers, especially if research goals include subsistence and settlement patterns and adaptive behaviors over time.

General Critique of Behavioral Ecology Applications in Archaeology

Critiques of behavioral ecology come from those practicing a behavioral ecology approach as well as from those in archaeology who do not subscribe to behavioral ecology in their research. Main criticisms from within include the need for methodological refinement of models and less reliance on ethnographic work to draw comparisons with the archaeological record, as well as realizing “optimization” may not be prescriptive and does not necessarily ensure reproductive success (Cannon and Broughon 2008: 24-5). The first point is addressed at length in Broughon and Cannon’s (2009) edited volume, since they view this as a constructive part of the scientific process. The second point is more difficult to address, though it is useful to keep in mind for those who argue against optimization that foraging models are only a tool to test hypotheses and are not a factual representation of human behavior.

Criticism from the outside approach usually aims at undermining the philosophical foundations of behavioral ecology, methodological individualism. The argument against this is that behavioral ecology considers individuals to be hyper-rational decision-makers who always behave in a way that considers the best outcome in the future. However, Cannon and Broughon (2009:32-33) stress that empirical modeling need not consider “omniscient actors,” but factors regarding needing to learn about survival and resources (information gathering) can also be hypothesized with models. Moreover, economists dealing with such models have incorporated experience and other determinants into equations, and hopefully this will catch on to behavioral ecology applications in archaeology soon.

Bibliography


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