The Search for a Paradigm in Archaeology Evolutionary Theory and the "Selectionist" School of Thought

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Abstract

According to evolutionary archaeology (the "selectionist" school of archaeological theory) the archaeological record can be explained in terms of generic Darwinian processes of evolution. Evolution is seen as the differential persistence of cultural traits and as the differential reproductive success of individuals in result of the cultural traits they possess. However, one of the major criticisms of evolutionary archaeology is concerned with the absence of a defined unit of selection. Evolutionary biologist Richard Dawkins and others have suggested that the same generic process as biological evolution governs culture change and that culture evolves as a result of the differential replication of cultural units, the memes, that play an analogous role as genes. If this is so, it is suggested that the unit of selection that might be lacking in evolutionary archaeology is the meme. Since memetics (the study of memes as cultural replicators) is a theory of cultural change it has the potential to provide the explanatory framework for the temporal and spatial patterns of archaeological phenomena. Despite its potential, memetics seems to introduce Lamarckian processes of evolution in the culture medium, which are not very explanatory. The purpose of this article is to show the potential of generic evolutionary processes in explanations of culture change and discuss the major problems involved in this theoretical approach.

Introduction

Although some debate exists concerning the ultimate goals of archaeology, traditionally it has been equated with the recovery, analysis and interpretation of material remains of the human past and the means to study cultural change and past human behaviour (Trigger 1989). Ultimately, however, the theoretical approach used has significant implications on the definition of those goals and on the way research is carried out.

A major controversy centres on the role played by theoretical explanations in the study of archaeological data and specifically what are called high-level theories. High-level theories have been defined as "abstract rules that explain the relationships among the theoretical propositions that are relevant for understanding major categories of phenomena" (Trigger 1989: 22). Thus, high-level theories are theories of ultimate causation, they answer *why* particular phenomena exist, as opposed to *how* they work. As a consequence of the above, some questions arise. What is the theoretical model or framework for archaeological research? Is there only one such model? What then is the archaeological paradigm? Some archaeologists argue that multiple theoretical approaches are fundamental to archaeology (e.g. Hodder 2001). Others argue that only one can actually provide the "big picture" (e.g. Dunnel 1980).

If we choose to recognize that the human capacity for culture is a product of biological evolution, theoretical explanations of cultural change must include evolutionary mechanisms, such as natural selection. *Homo sapiens* are of the few species that have culture as an extra medium to preserve and transmit information, besides genetic material (Dennett 1995). Other life forms have rudimentary modes of culture but humans have elevated it to a point no other species have. From Acheulean axes to space ships and from first farmers to genetic engineering of other living organisms, humans have altered the face of the Earth in an instant of geologic time. Culture has changed the course of human history and evolution in such a fundamental way that its effects can overlay the earlier genetic pressures and processes that created it. However, despite its tremendous influence, culture as not been able to overlay them completely.

The purpose of this paper is not to give support for evolutionary theory, understood in its biological sense, as *the paradigm* for archaeology, rather it is to show that it has potential for archaeological explanations of cultural change. Although the question of whether evolutionary theory could be considered the paradigm in archaeological research is a very pertinent one, it is out of the modest aspiration of this work. The intention of this paper is not to cover all significant aspects of evolutionary theory and how its systems were extended to include the archaeological record. A full discussion of this can be found elsewhere (e.g. O'Brien 1996; Barton and Clark 1997a). My goal is to focus on the most important and fundamental theoretical aspects of the application of evolutionary theory to the archaeological record. However, to accept an evolutionary approach in archaeological research we must also recognize a materialistic view of the world. This is in contrast to the traditional essentialist view of the archaeological record and of cultural phenomena. A materialistic approach sees species and social groups as historical entities, meaning that they are the product of cumulative change over time and are always in the process of becoming. In contrast, an essentialist approach sees the same entities as fixed and stable in time.

Modern Evolutionary Theory

Modern evolutionary theory or Neo-Darwinism is the result of the reconciliation of the Darwinian theory of evolution by natural selection and Mendelian genetics. This reconciliation occurred in the 1930's through the independent theoretical work of S. Wright, J. B. S. Haldane and R. Fisher. Their synthesis demonstrated that natural selection could operate with the kinds of variation observable in natural populations and the laws of Mendelian inheritance. The modern synthesis soon inspired others and the theory was further developed through the works of T. Dobzhansky (1951) in population genetics, E. Mayr (1942) in systematics and G. G. Simpson (1947) in palaeontology.

The biological definition of evolution is change over many generations of cumulative selection acting on living organisms over long periods of time in an unpredictable direction (Ridley 1996). This definition is important, in that it should not be mistaken for cultural evolution. Cultural evolution is a schema of human social development that includes notions of morality and progress, where societies evolve from primitive to civilized (Johnson 1999).

Most modern explanations of biological change rely on the principle of natural selection put forth by Darwin. However, the heuristic power of his theory of evolution by means of natural selection resides in the fact that it is a generic algorithmic process (Dennett 1995). This means that no matter what the context and the mode of inheritance, if certain conditions are met, natural selection automatically occurs. These conditions are as follows (Dawkins 1976, 1983; Dennett 1990, 1995):

(1) variation: the existence of different elements;
(2) heredity or replication: the elements have the capacity of create copies or replicas of themselves;

(3) differential fitness: due to features of its environment some elements are more likely to replicate than others.

In this way the theory is not limited to biological systems and is a more general abstract characterization of evolution. This is what Dawkins (1976, 1983) has called "Universal Darwinism" and Dennett (1995) termed "Darwin's Dangerous Idea". The fundamental principal for biology is that all life evolves by the differential survival of replicating entities and that entity is the gene (Dawkins 1976, 1986). Although the process of variation selection through time is without purpose, it generates design out of chaos (Dawkins 1976, 1986). Evolutionary theory is at the highest level of theoretical interpretation because it answers why, as opposed to how, things work and in this sense is an explanation for ultimate causation. This emphasis on natural selection should not blind us to the fact that other mechanisms of evolutionary change are at work. One such mechanism is genetic drift and refers to change as the result of random modifications over time in competing genotypes that have neutral adaptative values (Ridley 1996).

The components in a general algorithm for Darwinian evolution are replicating entities of some kind. Thus, the replicator is defined as an entity that passes on its structure directly in replication (Dawkins 1976; Hull 1982). The paradigmatic replicator is the gene. An interactor is an entity that directly interacts, as a cohesive whole, with its environment in such a way that replication is differential (Hull 1982). Here the interactor is defined in the same way as the vehicle (Dawkins 1976; Ball 1984) and the paradigmatic interactor or vehicle is the organism. In the end, replicators and interactors function in the evolutionary process to produce lineages. According to modern evolutionary biology, livings things exist because they provide the vehicle that allows a replicative entity (gene) to replicate (reproduce) and livings things change so that they can provide the vehicle for the best replicating entities.

Of importance to this discussion is the definition of the particular kinds of characters that are used in the study of lineages or evolutionary relations between living organisms. These are *homologies* and *analogies*. A homology is a character shared between species that is also present in their common ancestor (Ridley 1996). An analogy is a convergent character, one that is shared between species but that was not present in their common ancestor (Ridley 1996). Homologous similarity reveals an evolutionary relationship, while an analogous similarity does not. Because analogies can group species that are not related, they are not reliable guides to evolutionary reconstructions of lineages of organisms. The ultimate result is that biological lineages over time produce a treelike, diverging, and hierarchical pattern of similarities among living things based on shared homologies (Ridley 1996).

In the natural sciences there are two opposite views of how sociocultural evolution works. On one side evolutionary biologist Richard Dawkins (1976, 1982) argues that culture evolves as the result of differential replication of memes, cultural entities that play an analogous role to that of genes. On the other side, palaeontologist Stephen J. Gould (1979, 1991) argues that biological evolution is not a good analogy for cultural evolution and that cultural change is Lamarckian in form.

The "Selectionist" School of Archaeological Theory

The "Selectionist" School or the "Dunnell" School of Archaeological Theory and Evolutionary or Darwinian Archaeology are all synonyms for the same stream of thinking in modern archaeological theory. Evolutionary archaeology should be understood as an explanatory framework that accounts for the structure and change evident in the archaeological record in terms of evolutionary processes either identical or analogous with neo-Darwinian evolutionary processes, such as natural selection (Dunnell 1980, 1989; Leonard and Jones 1987; Barton and Clark 1997b; Lyman and O'Brien 1998). It was initially developed and promoted by the North American archaeologist Robert C. Dunnell (1978a, 1978b, 1980; hence the "Dunnell" School) and it is frequently stated that it gives a central role to natural selection (and hence the "Selectionist" School).

The basic premise of evolutionary archaeology is that artefacts are part of the human phenotype and are therefore subjected to the same evolutionary processes (natural selection and drift) as any other somatic feature. This is achieved by using the concept of extended phenotype introduced by Dawkins (1982). According to Dawkins, all the effects or products of a gene on the world, not just on the organism in which it 'lives', are parts of the phenotype. Recognized as such are the beaver's dam, the spider's web and the bird's nest. Evolutionary archaeology recognises material culture or artefacts as being part of the human extended phenotype and therefore it is the differential representation of variation at all scales among artefacts for which evolutionary archaeology seeks explanations (Dunnell 1980, 1989; Lyman and O'Brien 1998). According to evolutionary archaeology the principal mechanism explaining the differential persistence of transmitted variation in the archaeological record is natural selection. In this way, evolutionary archaeologists explore the concept of natural selection as a universal mechanism and the abstract definition of evolution by natural selection.

Leonard and Jones (1987) significantly expanded the early formulations of evolutionary archaeology by introducing the notion of *replicative success*. They maintain a distinction between individuals, who have *reproductive success* and cultural traits of those individuals, which have only replicative success. Thus, human cultural traits have differential replicative success in the same way that particular traits of organisms have differential replicative success. Those cultural traits that affect the reproductive success of the bearer are considered *functional* and those with neutral effect are termed *stylistic* (see below).

Supporters of evolutionary archaeology have also argued that archaeology shares a basic ontological perspective with evolutionary biology because both are time-like sciences of constant change. In this way it has some parallels to modern paleobiology (Lyman and O'Brien 1998). It seeks to provide Darwinian explanations of the archaeological record, just as paleobiologists explain the fossil record. The explanation of the archaeological record given by the evolutionary archaeologists involves first, the building of cultural lineages and second, constructing explanations of those lineages for being the way they are (Lyman and O'Brien 1998).

The theoretical structure of evolutionary archaeology stresses the distinction between aspects of artefacts that can affect the fitness of individuals and, traits having such effects are termed functional, whereas traits that are neutral with respect to fitness are termed stylistic (Dunnell 1978b, 1980). Temporal and spatial distributions of functional traits are determined by selection, whereas those of stylistic traits vary stochastically. The concept of style, explicitly incorporates the biological notion of drift, since distributions of particular artefact styles over space and through time are solely the result of transmission (common descent) they represent homologous similarity (Dunnel

1978b; O'Brien and Holland 1990). It is the recognition of functional and stylistic traits that allow the reconstruction of cultural lineages. According to O'Brien and Lyman (2000) and to Lipo and colleagues (1997) one way of recognising homologous similarity and heritable continuity is through the use of seriation, in which seriation groups represent cultural lineages.

Selectionists, however, seem to focus on the replicative success of artefact types *and* on the reproductive success of individuals (Leonard and Jones, 1987; O'Brien and Holland, 1990). In this way, evolutionary archaeologists focus on traits of material culture that have effects on the differential reproduction of individuals who possess them and on the differential replication of the artefacts themselves. Evolutionary archaeologists believe that frequencies in cultural traits change due to differential reproductive success of individuals and due to differential replicative success of artefacts. However, replicative success of artefacts may or may not affect the reproductive (genetic) success of the bearer (the individual).

There are five main criticisms that are apparent in evolutionary archaeology: (1) absence of a well-defined unit of cultural transmission; (2) rejection of human intent; (3) absence of convincing linkage between data and theory; (4) biological evolution is not a good analogy for cultural evolution; (5) it is an extreme reductionist approach to cultural change.

Perhaps of the utmost importance is the absence of a well-defined unit of cultural transmission. As O'Brien and co-workers (1998: 494) state, "The greatest weakness of evolutionary archaeology to date is determining how to measure transmission", which means that processes and mechanisms of transmission and the appropriate unit of selection have not yet been established. The question is: "What exactly is selection acting upon?" (Maschner 1998: 355). On the other hand, evolutionary archaeologists do not seem to recognize the importance of the definition of the unit of selection (Lyman and O'Brien 1998). The first of their arguments states that biology made use of evolution for many decades before it was able to identify units of transmission. What these authors seem to disregard is that the definitions of the unit of selection gave a great deal of strength to Darwinism, specifically as a consequence of the modern synthesis of evolutionary theory. The second argument refers to the fact that archaeologists would not know how such units were to be identified in the archaeological record.

However, in the same way as paleobiologists, whom they argue they have a great deal in common with, do not seek or try to identify genes when studying fossil organisms. The importance of the definition of the unit of selection resides in the *explanation* of evolution.

The role of human intent is perhaps one of the most contentious issues surrounding evolutionary archaeology, since it seems to introduce Lamarckian mechanisms of evolution. Applying evolutionary theory to culture also assumes an analogy between biological evolution and cultural evolution. However, the basic biological units of selection do not seem to have an equivalent in culture. As opposed to biological evolution, cultural lineages not only diverge but also converge and intermingle (Lyman and O'Brien 1998). As Gould (1991:65) points out: "The basic topologies of biological and cultural change are completely different. Biological evolution is a system of constant divergence without subsequent joining of branches. Lineages, once distinct, are separate forever". In human history, on the other hand, the major source of cultural change is the convergence and intermingles of lineages. Some answers to these criticisms mentioned above will be provided within the text of this paper.

Directed Variation and Lamarckian Mechanisms of Evolution

Many researchers who write about sociocultural evolution seem to agree that it is Lamarckian to some extent (e.g. Wimsatt 1999; Cavalli-Sforza 1986; Ingold, 1986). However, the term Lamarckian evolution has come to refer to just one aspect of the evolutionary theory of Jean-Baptiste de Lamarck. This particular aspect has become more central than ever before. In its original formulations Lamarckism included concepts of inevitability of progress in evolution caused by the tendency of organisms to strive towards their own improvement, modifications brought about by the use and disuse of parts in response to the environment and the inheritance of such modifications. However, what is now referred to as Lamarckian evolution is the principle of the inheritance of acquired characteristics. In its historical sense, Lamarckism is a theory of directed variation (Gould 1979, 1991). In the modern sense, the inheritance of acquired characteristics is a source of variation against which natural selection acts (Balter 2000; Jablonska *et al.* 1998; Landman 1991, 1993).

In the historical sense of Lamarckism, inheritance of acquired characteristics was coupled with an "inner striving" that drives adaptation, or in other words, the mechanism of transmission is coupled with the concept of directed variation and adaptation, so that there is selection in the direction of increased adaptadeness. In the modern sense, which does not include the concept of "inner striving" in the direction of increased adaptadeness, not all of the acquired traits are adaptative or improvements. In this way, with respect to adaptativeness, the acquired characters resemble random mutations, and like mutations, are subject to natural selection. Consequently, evolution still has to rely on a Darwinian mechanism for its adaptative direction.

The difference between historical Lamarckism and Darwinism is as follows. In the former, transmission is direct; an organism perceives the environmental change, responds in the "right" way and passes its appropriate reaction directly to its offspring. In contrast, Darwinism requires two separate processes. The first step is the generation of random variation, with respect to the direction of selection, in organisms. The second step is selection acting upon that variation in adaptative directions ("the right way"). Lamarckism, in the modern sense, is a mechanism in Darwinian evolution because it is a variation generating mechanism.

However, some (Williams 1981; Hull 1982; Dennett 1995; Blackmore 1999) consider that cultural inheritance can only be perceived as Lamarckian in the unique sense that inherited characters are not coded in the genome. This means that there are no genes that code for specific cultural traits. So if we believe that cultural traits are subjected to natural selection, where are they coded and what is the unit of selection?

According to Wimsatt "cultural traits are not received all at one time (as in biological traits in the fusion of gametes and formation of the zygote) instead they are acquired over time throughout accumulation, generation, and modification and in turn mediate development, learning and socialization throughout the life cycle" (1999:288). Thus it is social learning that is supposedly Lamarckian, because knowledge is not passed from person to person genetically.

Behavioural inheritance through social learning and language-based information transmission allow the inheritance of acquired characters (Jablonska *et al.* 1998). These systems allow certain outcomes of the interaction between the organism and its environment to be incorporated into and maintained within the information-carrying system as well as the information to be transmitted to future generations. In cultural evolution this involves the social inheritance of learned or taught behaviour, or socially acquired adaptations (Campbell 1979; Jablonska *et al.* 1998; Blackmore 1999). Following Boyd & Richerson (1985:33), we may define culture as information capable of affecting individuals' phenotypes, which they *acquire* from other con-specifics by teaching or imitation.

It is argued (Boyd and Richerson 1985; Cavalli-Sforza 1986; Ingold 1986) that behavioural variability is not randomly generated in cultural evolution. Instead, individuals and groups of individuals pursue strategies that they assume will promote their own interests. Therefore cultural variation is introduced by innovation, which is a non-random form of variation and is frequently the result of an intentional improvement of a particular situation or solution to a problem. If in fact it is recognised that socially acquired information is coupled with intentional improvement(s) of individuals, then it can be said that culture change is Lamarckian, in its historical sense.

GENES, MEMES AND THE UNIT OF SELECTION

In biological evolution, even though selection can operate at various levels (Lewontin 1970), the unit of differential reproduction or selection is the gene (Ridley 1985). The organism as a whole is not considered the unit of selection. This is because all the cells of an organism are identical and the genes of all the cells are reproduced through a single cell line (the germ line), which means that the evolutionary fate of all the cells is coupled. The resulting corollary is that there is no conflict between gene selection and individual selection.

Dawkins (1976, 1982) and Dennett (1995) argued that the same process of universal Darwinism governs culture-change and that culture evolves as a result of the differential replication of *memes*. Memes are replicators that are subjected to Darwinian principles of evolution as genes, but in a cultural medium (Dawkin 1976; Dawkins 1982; Ball 1984; Dennett 1995; Tracy 1996; Aunger 1999; Wimsatt 1999). Thus, in this medium the memes represent the unit of selection.

"A meme or cultural replicator is an entity [that] is capable of being transmitted from one brain to another" (Dawkins 1976:210). Examples of memes are ideas, stories, songs, habits, skills, inventions, ways of making pots, building arches and ways of doing things that we copy from person to person by imitation (Dawkins 1976; Dennet 1995; Blackmore 1999, 2000). A particular successful style of clothing can be considered a good meme, because many imitate it. Ball (1984) and Dennett (1995) generally consider a meme as the smallest recognizable pieces of cultural information. Genes are invisible and are carried by gene vehicles (organisms) in which they tend to produce characteristic effects (phenotypic effects). Memes are also invisible and are carried by meme vehicles (pictures, books, sayings, tools and buildings) to produce cultural traits.

According to Dawkins (1976), the theory of evolution by natural selection is neutral regarding the difference between genes and memes. They are just thought to be different kinds of replicators evolving in different media at different rates. Like genes, memes are in competition with one another and are subject to selection. The general algorithm of evolution by natural selection may be formulated either with the gene (biological evolution) or with the meme (cultural evolution) as the replicator. This in turn means that we can explain the human past in terms of differential replicative success of two kinds of entities (replicators – genes and memes) and in regard to the effect memes can have on genes (cultural over biological). In other words, human biological evolution can be influenced by genes (according to its differential replication) as well as by memes (according to the effect it has on gene replication), but cultural evolution can only be influenced by memes and not by genes (at least directly). A meme can have high replicative fitness but also can provide high reproductive fitness to the body in which it "lives". When the direction taken by memetic evolution affects the direction of genetic evolution, Blacmore (1999) has called it memetic drive (an analogy to genetic drive).

Moreover, cultural traits (memes) may be favourably selected despite unfortunate or neutral consequences for biological fitness, perceived wellbeing or group survival. Some examples are astrology, celibate priesthoods, potlatch ceremonies and the chewing of bubble gum (Williams 1981:257). Therefore, memes can sculpt culture whatever the effect on genes or on individuals. According to this view, memes could be considered as viruses (Cullen 1993), striving to replicate themselves whatever the consequences for their host. Motivation for replicating memes that are unfavourable to the reproductive success of individuals is that over evolutionary time memes that had a positive effect over an individual fitness would be replicated and individuals who were good imitators would also benefit by replicating that meme (Blackmore 1999, 2000). Therefore it is argued that human brains were designed to be good imitators of memes, whether good, bad or simply neutral.

Some (Dennett 1995; Lake 1998; Horrocks 2000) consider that much of the mutation that happens to memes is directed in some way. "Memes are not the cumulative product of millions of *random* (undirected) mutations of some original idea, but each brain in the chain of production added huge dollops of value to the product in a non-random way" (Dennett 1995:354). An important question then is whether variation in memes arises in a random way or if it is directed. Some would say that it is directed because a meme is intentionally modified to achieve an intent or goal (Horrocks 2000). If it is directed then memes follow the historical Lamarckian type of evolution (directed evolution) as they are socially and culturally acquired and are modified in the "right way".

Since memetics (analogous to genetics) is a theory of cultural change it has the potential to be applied to change in the archaeological record and provide the potential explanatory framework for the temporal and spatial patterns of archaeological phenomena. This is not to say that memetics is accepted without question or criticism (e.g. Lake 1998) but reflect the fact that memetics, as a theory of cultural change, is in its early stages of development. In a similar way already mentioned above, it could be said that culture exists because it provides the vehicles that allow a replicative entity (meme) to replicate and that culture changes so that it can provide the vehicle for the best replicating entities.

Evolutionary Explanations for the Archaeological Record

Ultimately, the emphasis of evolutionary archaeology is showing that a particular cultural trait has a high fitness value (Lyman and O'Brien 1998; O'Brien and Holland 1990). Using pottery work as an example, this involves answering three questions (O'Brien and Lyman 2000): (1) does a particular kind of pottery work better within the particular time-space position it occupies than does another kind of pottery?; (2) what is the selective environment in which it is found and what were the selective environments that led to its appearance?; and

(3) What was the history that led to that kind of pottery's establishment?

Inferring the potential fitness of artefact variability requires archaeologists to use other sources. Ethnoarchaeology and actualistic studies can be used to reconstruct past events and phenomena by analogy, using information derived from the present to explain data from the past. However, according to Dunnell (1989) and O'Brien and co-workers (1998) relations between behaviour and material must be invariant if they are to serve as timeless, space less rules of reconstruction, in order for them to be used in prediction. Such a partial use of ethnographic analogies and actualistic studies is an important limitation imposed on evolutionary archaeology. Since explanation for behavioural change is one of the major goals of archaeologists, Dunnell's assertion means that those relations must rely on the principle that behaviour cannot change. This is why Dunnell and colleagues believe that ethnographic analogies and actualistic studies are flawed.

In an evolutionary framework, ethnographic analogies are not completely invalid. They should, however, be carefully carried out because ethnographically studied groups are not our temporally displaced ancestors, but instead they are our "phylogenetic cousins" (O'Brien and Holland 1995). Archaeology has to rely on analogy since evolutionary theory does not make past processes self-evident (Mithen 1989). Take for example physical anthropology, a discipline that is close to archaeology. Much of what is reconstructed about human biological evolution is based on analogies with ethnographic groups and living primates. Physical anthropologists assume that the biological processes and mechanisms that we see at work today are the same as those in the past, meaning that they rely on uniformitarian principles. In fact, many of the interpretations regarding hominid locomotion, mating patterns or diet, are supported by such analogies (e.g. Hrdy 1995; Jablonski and Chaplin 1993; Wood 1986). However, the reliability of the inferences decreases rapidly as the behaviours are distanced phylogenetically. This means that the further we go into the past the more biased the analogies will become. The rejection of actualistic studies and ethnographic analogies by evolutionary archaeologists, when they are not based in timeless and space less rules, is one of the main differences that prevents the synthesis of three archaeological schools of thought that share the same theoretical paradigm: evolutionary archaeology, behavioural archaeology and evolutionary ecology (Broughton and O'Connell 1999; Schiffer 1996). Although correlations between material culture and behaviour indicate *what* happened in the past, they do not explain *why* events happened (Trigger 1989). This may in fact be where the explanatory power of evolutionary theory can be used.

As the result of what as been presented above, the meme can provide the unit of selection that has been missing in the application of evolutionary theory in archaeological research. Since meme transmission and storage can proceed indefinitely *in artefacts of any kind* (Dennett 1995:354), (artefacts such as stone tools and pots) it can be measured indirectly from the study of human artefacts. However, in an absolute sense, the proposition that the meme is replicated through some kind of vehicle is perhaps untreatable in archaeology. Archaeologists cannot monitor genetic or memetic change directly from the archaeological record, but they can assume that the changes they see in artefacts reflect it. Palaeontologists, similarly as archaeologists, cannot monitor genetic change from the fossil record.

Some examples can be provided of how the meme concept could be incorporated into evolutionary explanations of the archaeological record. Neff discussing the theory of how patterns of ceramic variation are generated and such analytical techniques, writes: "Because pottery-making information is transmitted through an inheritance system, ceramic traditions must be subject to mechanisms of change peculiar to inheritance systems" (1993:26). What Neff means by "mechanisms of change" is natural selection and if we ignore the kind of inheritance system we can interpret the expression of "pottery-making information" as a meme. He further reinforces this interpretation: "Information (memes) that leads to potters to exhibit successful phenotypic characteristics tends to become more common, while information (memes) that leads them to exhibit unsuccessful characteristics tends to become less common." (Neff 1993:26; brackets added). Other fruitful examples are that of Mithen (1989) when discussing the role of evolutionary theory in post-processual archaeology. "It may be advantageous to copy not just the hunting weapons (the "hunting weapon" meme) of a successful hunter but also his style and patterns of social interaction (other memes) for all may contribute to his hunting efficiency (and consequently to his fitness)" (Mithen 1989:484; brackets added). Higgs (*in* Horrocks 2000) states that: "Certain memes such as methods of crop cultivation and new techniques for making tools and weapons, would have had a significant effect on the ability of individuals in primitive societies to survive and bring up children". Lastly, Lake (1998) suggests that spatial properties shared by settlements can be considered memes, because they code for specific cultural traits. He also suggests that the persistence of those memes through time will depend on their own replicative success or on the effect over the reproduction of the individuals in which those memes "live".

One of the problems of applying evolutionary archaeology to cultural change is in explaining the evolution of complex societies in which cooperation exists between non-related individuals. In contrast, kinship as a basic organizational principle of human society is a direct prediction from inclusive fitness. Dunnell (1978a, 1980) suggests that the appearance of complex societies based on functional relationships between non-related individuals is a consequence of selection operating at the group level.

In biology, group selection is considered only a very weak force in evolution (Ridley 1985, 1996). Because individuals act in their own selfish interest, selection will hardly cause individuals to sacrifice their own reproductive interests (i.e. to behave altruistically) to those of their group. The only exceptions are genetically related groups, for which altruistic behaviour can be explained by kin selection. However, Wilson and Sober (1994) argue that group selection is favoured by mechanisms that reduce the differences in fitness within the groups and increase differences between groups, thus concentrating selection at the group level. Indeed, Boyd and Richerson (1990) have provided such mechanism. They have used a mathematical model to show that group selection is particularly likely to occur when behavioural variation is culturally acquired. Later, Blackmore (1999) argued that particular memes, such as religion, could have the effect of decreasing within-group differences and increasing between group differences. "Within many religions conformity is encouraged, forbidden behaviours are punished, differences between believers and unbelievers are exaggerated, fear or hatred of people with other beliefs is nurtured and migration to a different religion made difficult or impossible" (Blackmore 1999:200). According to Blackmore, all of this makes group selection more likely to occur and if genetic differences between the groups exist, then differential survival of groups would have effects on the gene pool. In this perspective, Watkins (2000) uses memetic evolution as a cognitive model for the emergence of religious representations in the Neolithic of southwest Asia and how it might connect to the origins of agriculture and the adoption of sedentary life in villages.

Evolutionary archaeology does not attempt to prove that behaviours behind pot making were conscious or unconscious attempts on the part of prehistoric potters to maximize their fitness. Instead, it tries to demonstrate archaeologically that users of superior pot-making technologies were potentially more fit than those using other technologies (O'Brien and Holland 1995; Neff 1993). For evolutionary archaeologists the goal is to demonstrate that those technological improvements had a significant impact on the reproductive success of humans. Intent and motivation are not causative in a scientific sense, they are part of the phenomena that require explanation (Dunnell 1980) and are ultimately "inherently unverifiable" in the archaeological record (Rindos 1985:84). Human intent is important but only in its role as a generator of innovation, not as a shaper of adaptations.

Discussion and Conclusion

In summary, the importance of evolutionary theory in archaeology relies on its power to explain change in terms of differential replication of cultural entities, using the algorithm of universal Darwinism. Change in material cultural and evolution of human populations can be explained in terms of selective advantages of memes, which replicate to their own advantage and can or cannot have an effect on certain genes or individuals. In other words, biological and cultural evolution are closely related and intertwined. On the other hand, cultural change seems to include other mechanisms of change, such as inheritance of acquired characters and directed variation. In the end, however, we must question if in fact biological evolution is a good analogy for cultural evolution. Ultimately, there may be some similarities between biological and cultural evolution. But the former has its own special features. There are four main differences between biological and cultural evolution. These are differences in (1) the units of selection; (2) the kinds of variation in the units of selection; (3) the velocity of evolutionary change; and (4) the kinds of transmission. Following Wimsatt (1999), the strict analogy between biological and cultural evolution is likely an inaccurate belief, because there are so much peculiarities of cultural mechanisms that don't fit into biological established definitions.

However, one of the major problems involving the application of memetics to the archaeological record is the apparent introduction of Lamarckian principles of evolution. Dennett (1995) recognizes that much of new variation that happens to memes is manifestly directed variation. Some memes are not the cumulative product of random (undirected) variation, but in fact each vehicle adds value to the product in a non-random way. Boyd and Richerson (1985) argue that one clear advantage culture has over genes derives from the combination of the process of learning and social transmission to create "Lamarckian" systems that speed up the evolutionary process. Cultural evolution can only be perceived as Lamarckian if the variation in the units of selection arises in non-random ways, i.e. the variation is directed. However, one important point made by O'Brien and Lyman is that "intention is indeed a boundless source of variation upon which evolutionary processes such as selection can act, but it is tautological to use intention as the ultimate cause of change" (2000:73). Individuals need not be aware of selective pressures or consciously motivated by individual fitness, so that decision-making and intended actions are in fact mechanisms shaped by natural selection to deal with specific problems. Individuals' decisions for the resolution of problems or improvement of a particular solution are made without the knowledge of the final outcome. Intentional decisions are made without knowing if they in fact will be improvements or resolutions. In such a way, intent can be seen as a behavioural response to particular situations and as such can be thought as phenotypic variability on which natural selection acts upon.

Memetics is seen as a contribution to social science, from outside the discipline (in this case biology), which does not take into account the complexities of social and cultural phenomena (Aunger 1999; Boyd and Richerson 2000). On the other hand, it is perceived by social scientists as "greedily reductionist" where the entire enquiry is subordinated under the algorithm of fitness maximization (Aunger 1999). An answer to the criticisms of extreme reductionism and oversimplification can be found in Ball, "To make a progress in understanding [the world], we probably need to begin with simplified (oversimplified?) models and ignore critics' tirade that the real world is more complex. The real world is *always* more complex, which has the advantage that we shan't run out of work." (1984:159; brackets added).

Acknowledgments

I would like to thank Professor Andrew Martindale for his stimulating classes and for a first revision of the text. I would also like to thank Carolann Wood for reading, and commenting on a preliminary version of this paper as well as the two anonymous reviewers for their suggestions and comments.

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