Darwin's Legacy:

The Status of Evolutionary Archaeology in Argentina

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Edited by

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PREFACE

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This book collects the contributions to the symposium *"The current state of evolutionary archeology in Argentina"* that was held in Buenos Aires, for celebrating the 200th anniversary of Charles Darwin's birth and the 150th anniversary of the publication of "*On the Origin of Species"*. The meeting was sponsored by the IMHICIHU-CONICET (Instituto Multidisciplinario de Historia y Ciencias Humanas-Consejo Nacional de Investigaciones Científicas y Técnicas).

In Argentina, as Scheisohn (2009) noted, the early adherence to Darwin's ideas by scientists such as Florentino Ameghino influenced the subsequent reception of the Darwinian theory of evolution in archeology. But the development of this early intellectual evolutionary tradition was overshadowed by the discredit of Ameghino for his claims about the human origins in South America, opening the avenue for the subsequent dominance of two main paradigms, the culture-history school and the *Kulturkreise* archaeology (Boschín and Llamazares 1986).

The *Kulturkreise School* had the greatest impact on the archeology of Pampa and Patagonia, where it was established by the work of José Imbelloni, Osvaldo Menguín, and Marcelo Bórmida since the 30th and during the mid twentieth century. The *Kulturkreise* practitioners were devoted to the modal description of the archaeological record, particularly that of the lithic assemblages classified as specific areas industries or cultures . At the core of this paradigm were a hiperdiffusionist notion of cultural change and a radical idealism and antievolunism by which particular cultures were conceived as byproducts of the *ethos* of particular groups or races, expressed through the manufacture of artifacts and other behaviors, and dispersed from a few geographical centers.

On the other hand, during the mid-twentieth century, the culture-historical approach was developed mainly in Northwestern Argentina after the influential work of Alberto Rex Gonzalez. The research agenda of Gonzalez focused largely on the construction of local temporal sequences based on ceramic typologies and radiocarbon dating (the so called master sequences) (see González 1963, 1979). Although ignored by many of his disciples, a very important point was the call of Rex Gonzalez for a research strategy oriented to the study of cultural evolution. Nevertheless, the theoretical background of Rex Gonzalez was a blend between a strong typological thinking and the teleological explanations of cultural change that dominated the evolutionism of Julian Steward.

The path to the introduction of a scientific evolutionary framework in the archaeology of Argentina was opened in the late 70´s and the early 80´s by the application of the agenda of the New Archaeology, developed primarily in the United States with the work of Lewis Binford (1962) and in England by Graham Clark and his influential *Analytical Archaeology*. This perspective redirected almost all of the research goals by the adoption of a hypothetical-deductive model of science which resulted in the study of the adaptive dimensions of past human behaviors along the development of methodologies for detecting variability and patterning in the archaeological record. However, the evolutionism of the New Archaeology perpetuated the non-Darwinian explanation of change based mainly on cultural ecology and systemic functionalism. In this vein, the explanation of change was assumed to be always adaptive, following the orthogenetic notion of systemic adaptation by the continuous searching of homoeostatic equilibriums that characterized past adaptive systems. Therefore, under the influence of the ideas of Lewis Binford and Kent Flannery, adaptive systems became evolving units, and their reconstruction in archaeological terms was the main task of the so called systemic archaeology. Under this adaptationist framework the research on the relationships between past behaviors and past environments started as a programmatic goal through the study of past adaptive strategies.

In northwestern Argentina the work of Hugo Yacobacio and Daniel Olivera changed the focus from culture history towards the study of past human adaptations to high altitude environments (Yaccobacio et al. 1998, Olivera 1988). Also, by virtue of this new agenda, the discussion of local evolutionary processes, such as the domestication of camelids in the Southern Andean region and the development of social complexity, was introduced.

In the archaeology of Pampa and Patagonia, the New Archaeology arouse as a vigorous reaction against the *Kulturkreise* archaeology and its bequest. Unlike the development of the new archeology in northwestern Argentina, in Patagonia, the introduction of this paradigm began with the discussion of processes that facilitated a gradual shift towards a Darwinian research agenda. After decades of anti-evolutionism thought, the archeology of Argentina began to be interested in processes like adaptive radiation and cultural divergence for explaining the archaeological variability of Patagonian record, which was dominated by the typological description of sites and lithic industries until then. In a series of seminal papers, Borrero (Borrero 1989, Borrero 1989-1990, Borrero 1992, Borrero 1993) settled the main distinctive issues of an early application of the evolutionary paradigm in Patagonia with an emphasis on biogeography, ecology, and taphonomy as the frameworks for explaining the variability of the archaeological record of Patagonia.

By the end of 80's the intellectual environment, especially at the University of Buenos Aires, began to be adverse to new archeology agenda, which had become the dominant paradigm of scientific archaeology by that time. This resulted in the proliferation of different lines of thought, among which Evolutionary Archaeology was highlighted by a large number of adherents that were working interactively in/for the development of a practical applicationto concrete case studies of a Darwinian evolutionary framework (Lanata 1995, 1996, Lanata and Borrero 1994, Scheinsohn 1997, 2002). Thus, throughout the 90's and well into the new millennium, a large number of students and young researchers broadened the application of the scientific evolutionism to the archeology of Patagonia (Barberena 2002, 2005, 2008) and northwestern Argentina (especially in the Puna, see Muscio 1999, 2004, Camino 2009, López 1998, López and Restifo 2009, Cardillo 2002, 2009), the northeast (Loponte et al 2006), and Cuyo and Sierras Centrales (Medina 2008, Neme 2009).

A peculiarity of the scientific evolutionism in Argentina archeology was the early adoption of a pluralist theoretical framework that integrated many different Darwinian approaches into a single evolutionary research agenda, thus ignoring the dicotomic opposition that characterized the development of the field in the U.S., between the so called selectionist school and other evolutionary approaches to human behavior, like Human Behavioral Ecology and the Theory of Cultural Transmission (see Scheinsohn 2008, 2009 for further discussion). Moreover, the English school also arrived at the beginnings of the new century and was added to this inclusive evolutionary paradigm (Shennan 2002). In the Argentinean tradition, an inclusive Darwinian theoretical framework evolved along a history of research where ecology and biogeography were always present by fuelling theory building around problems like the human colonization of the South-Andean region and Patagonia, and the emergence of productive economies in the puna region. Consequently, the intellectual challenge undertaken during the 90's was the articulation of biogeographical and ecological approaches with the key Darwinian sources of causality: variation and selective retention. In this way the search was one of integration into an inclusive paradigm of a variety of Darwinian approaches, a goal shared by a critical mass of researchers (Scheinsohn 2009).

Evolutionary archeology is the application of the Darwinian model of evolution to the study of the archaeological record -a fossil record- through the documentation of archaeological patterns of selective and non-selective evolutionary change. This theoretical framework in no way is reducible to the action of natural selection. Above all, Darwinian evolution implies a variational model of evolutionary change which is confronted to the transformational model of evolution based on typological thinking and teleological explanations. In this vein, the work of Borrero had the merit of challenge for the first time the omnipresence of the typological thinking in the archaeology of Argentina. This was a crucial step in the further development of the Evolutionary Archaeology in Argentina.

As Scheinsohn (2009) suggested, the reception and development of Evolutionary Archeology in Argentina comes from the influence of evolutionists like Ameghino and Holmberg. However, according to the author the acceptance and the variability of approaches framed within the broad spectrum of Darwinian approaches probably is the result of the relative scientific insularity of the academia in Argentina, regarding other centers of theory building, like the Anglo-Saxon countries, which are subject to other competitive forces in their academies. This volume is just a sample of the diversity of approaches and research issues vigorously conducted in Argentina.

INTRODUCTION: EVOLUTIONARY ARCHAEOLOGY A COMPREHENSIVE FRAMEWORK

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In the *Origins of Species* Charles Darwin concluded that the diversity of life arose by common descent through a branching pattern of evolution resulting from the accumulation of heritable variation preserved by natural selection. In the *Descent of Man* (1871) and by discussing the evolution of languages, Darwin asserted that cultural variants form genealogies by inheritance, and engage competitive relationships by which some variants proliferate whereas others become extinct. In this way Darwin clearly expanded the action of selection to culture. Thus, the contribution of Darwin to science was an inclusive and materialistic *model of evolutionary change* that encompasses everything which is subject to inheritance, variation, and differential replication.

The Darwinian model of evolutionary change is much more than evolution by natural selection as it describes the pattern of change that Lewontin (1983) called *variational evolution.* For Darwinian evolution, the occurrence of variation is a necessary condition, be it adaptive or neutral, blind or goal-oriented produced variation. Darwinian evolution implies that individuals in an evolving population vary from one to another, and that these variations may accumulate during evolution due to a sorting process by which some variants become either more or less common. The evolving populations may be formed by biological or cultural entities because both are subject to inheritance. Under the Darwinian model of evolution the sorting process -be it selection or random processes like drift- changes the proportions of the different variants in the population, figure 1-a. Conversely, Lamarckian evolution or "transformational evolution" does not assign any role to variation or sorting process. Transformational evolution is based on a typological concept of individuals by which all individuals of a population in a given environment simultaneously acquire the same structures and adaptations as the result of an inherent progressive tendency which drives them continuously towards greater complexity and to produce environmental induced hereditary adaptations (Figure 1). In this way Darwinian evolution, not the neo-Darwinism that emerged by the modern synthesis, does not preclude environmental induced variation as long this sort of variation became part of the variability subject to selection and other sorting forces (Kronfeldner 2007).

It is well know that cultural evolution has instances by which novel heritable variation arises as environmentally induced

behaviors by adaptive learning. But this variation remains subject to selection and other non-transformational population level process of evolutionary change, like imitation. The central issue is that problem solving cannot produce perfect solutions for adaptation, but more or less suitable alternatives. Then, the variation designed to solve a given problem will compete with other alternatives. Because of this, the evolution of culture is Darwinian, not neo Darwinian. This was proved by an increasing body of evidence that documents that culture mostly evolves following a pattern of descent with modification, i.e. the Darwinian branching pattern of evolution. As its biological counterpart, cultural evolution also has instances of reticulation by the horizontal transfer of information among independent lineages. Also, as in biology, the documentation of branching or reticulate patterns of cultural evolution is an empirical matter. Darwinian selection is a population level mechanism that sorts heritable variation (cultural or biological) by differences in the probabilities of competing variants to be successfully replicated. As a probabilistic mechanism, Darwinian selection is not reproductively based.

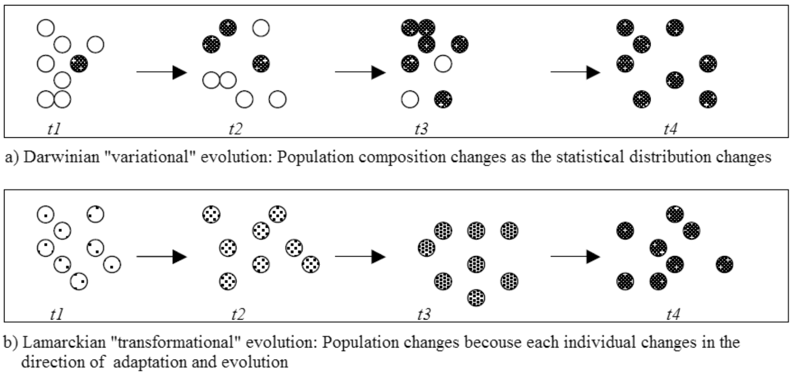

FIGURE 1: VARIATIONAL VS. TRANSFORMATIONAL EVOLUTION, MODIFIED FROM KRONFELDNER 2007.

On this basis Evolutionary Archaeology is a scientific research framework that seeks to explain the archaeological record in terms of Darwinian evolution, through the documentation of archaeological patterns of selective and non-selective evolutionary change. To achieve this goal, Evolutionary Archaeology conceives the archaeological record as a fossil record that provides information about macroevolutionary patterns of evolution resulting from microevolutionary process of selection and transmission.

Differential reproductive success, by selection acting at the scale of the individuals, is one way by which alternative variants achieve replicative differentials. For instance a trait subject to cultural inheritance will result fixed in a population whenever it contributes more than its alternatives to the reproduction of the individuals possessing the trait. As an example, Rogers and Ehlrich (2008) found that 96 cultural traits of Polynesian canoes with effects on the survival and reproduction of the individuals evolved following a selective pattern of retention. Thus, this process acts through the increase or the decrease in the population of the individuals that transmit alternative cultural variants to others.

Another powerful way by which alternative variants achieve replicative differentials is *by selection acting at the level of the cultural variation,* through the existence of a bias acting on the replication of alternative cultural variants. For instance, with selection acting at the scale of the artifact, a trait will result fixed at the population level if it contributes more than its alternative variants to the replicative success of the artifacts possessing the trait. In this way, assume the existence of a replication bias for the quick removal of projectile points after impacting on preys. In this context, points without barbs will have greater replicative success than barbed points and because of this they will result fixed at the population level (Dunnell 2006, see also Hughes 1996). This process is called *cultural selection*, and acts through the differential replication of the cultural variation by processes of biased cultural transmission. As replicative success by cultural selection is decoupled of the differential reproduction of individuals, deleterious cultural variation can be circumstantially retained by maladaptive replicate biases until being removing by purifying selection acting against the individuals carrying the deleterious traits (Durham 1992).

Because natural selection has found in social learning a quick way to generate heritable adaptations, in cultural evolution it is expected that cultural selection prevails. However, the prevalence of some form of selection over another is an empirical question that should be discussed case by case.

Cultural transmission and traits replication depends on social learning. Based on the Dual Inheritance Model (Boyd and Richerson, 1985, Durham 1992), there is a bulk of mathematical work showing the way in which social learning produces microevolutionary change and cumulative evolution at the population level, as well as the reasons by which cultural transmission evolved by natural selection along human evolution.

In cultural evolution the emergence of novel variation may result from error transmission (the analogous of mutation) or from adaptive problem solving. This latter instance of problem solving invention is Lamarckian only in the restricted sense that introduces environmental instructed variation by adaptive learning; but because this variation depends on being fixed within the population of the action of selection (by imitation or by individual fitness gains), the population level pattern for the adoption of this variation is not transformational but Darwinian (see Ginóbili this volume).

In addition, because Darwinian evolution is variational, this framework also includes the evolutionary change that occurs by stochastic processes acting on cultural variation. Many cultural changes may take place on purely selectively neutral variation. Neutral evolution occurs by processes that randomly sort cultural transmission, so that some traits are differently replicated just by chance, for example through cultural drift. In small populations cultural drift might cause the extinction of cultural variants due to chance effects on transmission (Henrich 2004). On this basis, the theoretical distinction between selective and neutral traits is critical (Dunnell 2001).

Moroever, Darwin´s explanation of evolutionary change due to the action of selection preserving advantageous traits, replaced the essentialist logic for conceiving adaptation by a materialistic one. Since Darwin, adaptation is defined in reference to natural selection. In a historical sense, a trait is an adaptation if it has been produced by natural selection for its current function. This is the definition of adaptation as an outcome of selection. From a processual point of view, adaptation is a process that refers to the action of natural selection building somatic and behavioral features of the organisms that make them better suited to survive and reproduce. This last definition is the notion of adaptation as a process. As natural selection acting along the evolutionary past has built a flexible human phenotype, behavioral flexibility is an adaptation that gives rise to a diversity of adaptive traits, behaviors, and life histories as response to varying ecological contexts. Behavioral flexibility is part of what is known as phenotypic plasticity, the capacity of a single genotype to exhibit variable phenotypes in different environments. It is clear that plasticity is important because it can increase or decrease fitness, generate novelity, and facilitate evolution (West-Eberhard 2003).

But a blind trust in adaptive phenotypic flexibility leads to ignore the mismatches that may occur between human populations and their changing environments. In fact phenotypic plasticity often is maladaptive (Ghalambor et al, 2007). Darwin gave many examples of maladaptations in order to show the way in which species are ill fitted to their environments. Maladaptations may arise when the environment to which a species is adapted changes, or when species or populations disperse to unfamiliar environments. Muscio (1999) has showed the maladaptive pattern of faunal consumption during the colonization of the puna of Argentina. Importantly, a profound mismatch between a species and its environment leads to extinction by directional selection (Haldane 1957).

The archaeological application of the Human Behavioral Ecology research strategy analyzes the *adaptive design* of past behaviors through formal models based on the selectionist logic of fitness maximization which in turn, and for heuristic proposes, is usually modeled as an optimizing problem. This theoretical approach is based on the adaptive decision making that is thought to be part of the behavioral flexibility of humans. Under this approach a number of topics are of evolutionary interest, like the archaeological patterns of resource transfer and consumption, habitat selectivity and space use, technological change, and social interactions.

The Human Behavioral Ecology approach is a powerful theoretical framework for studying past social dynamics. For instance, López (2008) proposed that during the late Holocene in the puna of Argentina the increase of demography and the spatial heterogeneity was followed by the decrease of the size of hunting social groups which also managed camelids in captivity. Based on the optimal group size model, individuals forming smaller groups maximized their return rates along more restricted habitats, setting the stage for the development of pastoral economies. Under this same approach, prestige- technologies and rock art scenes displaying social distinctiveness were interpreted as the archaeological evidence of the emergence of social orders based on social heterogeneity and leaderships associated with the first food producers societies in the northern puna of Argentina (Muscio 2006). In this model, social heterogeneity and leadership resulted from intragroup competition. Importantly, the shift towards smaller social groups discussed by López, and the social behavior of recognizing leaderships for ordering intragroup competition discussed by Muscio, both are part of the behavioral plasticity of humans regarding social behavior and decision making, created and maintained by selection. Then, if we grant that the Human Evolutionary Ecology provides tools for studying the emergence and the adaptive design of technologies and complex behavioral patterns at behavioral time scales (Smith 2001), we must also give a causal role to the selective forces of cultural transmission for the preservation of this adaptive variation at the scale of the population and in the long run. Because Human Evolutionary Ecology is silent regarding how adaptive variation is preserved along evolutionary time frameworks, we must introduce the action of evolutionary mechanisms as transmission and selection for a complete explanation of this critical issue.

For instance, adaptive technologies are expected to follow predictable patterns of convergence as environmental conditions are similar. In this way we can appeal to models based on the Human Behavioral Ecology approach for studying these convergences in adaptive design. Technologies that have a high potential for convergence were studied in Patagonia by Cardillo et al (2013) where it is documented that hunter-gatherer groups which were distanced for more than 1000 km shared similar technological adaptations regarding the harvesting of marine resources. On the basis of our current knowledge about human adaptive learning and its effects on cumulative cultural evolution, we must conclude that the long-term *persistence* of these technological convergences at the scale of the population is mediated by the action of cultural transmission, and not by the continual reinvention of this variation as a pure decision making process would imply.

In this way, *invention* (a novel goal-oriented produced cultural variation) and *innovation* (a retained invention) are useful heuristic concepts in cultural evolution. For instance, technological innovations have been documented by López (2009), and López and Restifo (2009), in the northern Puna of Argentina. In this case, processes of adaptive cultural innovation have been invoked to explain the emergence and spread of laminar lithic technology during the mid Holocene in a context of increased population density, economic intensification, and increased social groups. This phenomena is absent in the southern puna of Argentina, suggesting a process of adaptive cultural divergence between the two regions. Moreover, the increasing diversification of lithic artifacts classes during the mid Holocene in the puna region was explained as an effect of an accelerated rate of cultural evolution dependent on an increasing demography, compared with the low rate of cultural innovations recorded during the early Holocene in small and fluctuating population contexts Muscio (2011)

In short, culture contains all the elements of a Darwinian evolutionary system, variation, inheritance, and differential replicative success; which results a) from the impact of the cultural variation on the probabilities of the individuals for transmitting their cultural variants to others; b) from the existence of replicative biases favoring some variants over others (cultural selection), and c) by chance events that interfere cultural transmission producing neutral evolution. Moreover, humans are a proved behavioral flexible species, from which a diversity of traits and behaviors as adaptive responses to varying ecological contexts results. Based on all these elements, Evolutionary Archeology has a broad and ambitious agenda: the explanation of the archaeological record in terms of the Darwinian theory of evolution by clarifying the causes and consequences of the evolutionary processes.

By its emphasis on blind variation and Mendelian inheritance, Neo-Darwinism is not an accurate framework for theory building on cultural evolution. Instead, considering the particularities of cultural inheritance, Darwinism with its focus on the differential persistence of variability is the proper theoretical ground for the study of emergence and evolution of cultural variation at broad spatial and temporal scales. The construction of a synthetic paradigm in archaeology based on the Darwinian model of evolution does not demand the suppression of theoretical diversity (Muscio 2009). Conversely, the consolidation of a common theoretical ground as the basis for the construction of a variability of models and alternative hypotheses which ultimately will fuel the natural selection of competing scientific ideas is required. This task needs a robust theoretical structure with middle range statements, that enables us to link the properties of the archaeological record with the complexities of the Darwinian theory of evolution.

About this book

Following Gould (2002) convergence, divergence, and parallelism are of critical importance in any evolutionary research agenda. From this point of view, the *introduction and persistence* of cultural variation along large time scales becomes archaeology a unique field for the study of human evolution by selection and other evolutionary processes by which convergence, divergence or parallelism arise in cultural lineages. As we have showed, the study of evolution in the archaeological record is based on the empirical fact that culture is an inheritance system, which is independent (but also related) from the genetic inheritance system. As such, cultural inheritance evolves forming cultural lineages.

The work of Santiago Ginnóbili, from an epistemological point of view discusses the nature of variation and its relation to the mechanism of natural selection described by Darwin itself, not by the Neo Darwinism of the modern synthesis. In particular, the paper focuses on the logical status of the directed variation by assessing the ways by which natural selection acts upon it. The work is an important contribution for those interested in cultural evolution, as it illuminates the fact that even when cultural evolution has Lamarckian instances this does not imply that it cannot evolve by natural selection.

As variation is central to evolution, the documentation of *variation* along space and time is a way for studying evolutionary processes in archaeology. Most of the papers presented in this volume address this issue. The building of cultural phylogenies is an important way to approach this question. Of course, the documentation of culture phylogeny raises new methodological challenges related to the properties of cultural inheritance as well as to the techniques used in phylogenetic reconstruction. Many of these challenges are creatively addressed by the authors in this book.

In his work, Daniel García Rivero critically introduces the main classification methods that are useful in Evolutionary Archaeology for phylogenetic reconstruction. The paper is concerned with the discussion of the assumptions of different philosophical schools of taxonomy: phenetics, cladistics, and evolutionary taxonomy, concluding that there is not consensus to prefer some method over another in Evolutionary Archaeology. In this vein the paper of Marcelo Cardillo also discusses phylogenetic reconstruction methods but on empirical grounds. The author also appeals to multivariate methods for detecting patterning in the distribution of artifactual variation by using parsimony as the epistemological basis to build cultural phylogenies through cladistics. This method is used in order to explore the evolutionary role of three dimensions: space, environment, and history, as sources of causality for explaining the technological diversity of the Patagonian coast.

Cladistics is a method for *hypotheses building* regarding evolutionary relatedness among taxa, and it is based on the principle of maximum parsimony- the preference of the simpler of two or more otherwise equally adequate explanations. In cultural evolution relatedness rests on cultural transmission. Hence, the first critical task in cultural phylogenetic reconstruction is the recognition of homologies: traits which are similar due to descent from a common ancestor. Cladistics reconstructs through dichotomous diagrams the successive changes of a set of traits grouped in classes which are more or less evolutionary related by common descent (see Farris 1983, 1986, Forey et al. 1992). Thus, cladistics traces evolution at the scale of the traits. Because by cladistics the separation of clades (monophyletic groups) is modeled as a branching process, the method follows the Darwinian pattern of divergent evolution consisting in descent with modification. Cladistics differs from other methods such as phenetic, because classes (terminal taxa) are grouped together based on whether or not they have one or more shared unique trait that come from the group's last common ancestor and are not present in more distant ancestors (*synapomorphies)*.

As García Rivero notes in this book, this is not the case of phenetics which focuses on overall similarity (see discussion in Sneath y Sokal 1973). However, as discussed by Rivero (in this volume) and Cardillo (in this volume), both methods, cladistics and phenetics, can be used comparatively in order to build phylogenetic hypotheses in cultural evolution under different assumptions (see also Shennan and Collard 2005). As was stated by Makarenkov and Legendre (2004), and by Sneath y Sokal (1973) at an intraclass level (for example, when comparing the variation within a class) we may be more interested in tracing the gradients of variation along a phylogeny than in the qualitative changes of traits. In this case, phenetic techniques (see Rivero, this volume) were developed for the quantitative study of evolution and are widespread, for example, in ecology and genetics.

But not only statistical appropriate methods to model character evolution are important, also the selection of correct cultural traits is critical. The paper of Gustavo Barrientos addresses the difficulties associated with the recognition of homologous traits in cultural datasets and its derivations for studying cultural phylogenies. After an insightful discussion of the potential sources of error for the identification of homologies, Barrientos calls for the building of a theoretical framework for homology recognition and testing by adopting a developmental perspective, based on the study of ontogenetic trajectories of artifacts on an individual and population basis. In this way the work of Barrientos contributes to the methodological side of phylogenetic reconstruction and its potentials for inferring macroevolutionary patterns of cultural change.

At the macroevolutionary scale, cultural evolution is traceable by the patterns of divergence, parallelism, or convergence documented by phylogenetic reconstructions and other methods (Gould 2002, see Collard and Shennan 2006, Cardillo and Charlin 2013). Shortly, divergent evolution is the accumulation of differences among human populations or artifacts classes which lead to the formation of new derived classes. Parallel evolution is the acquisition of a similar trait in related, but distinct, human populations or artifact classes descending from the same ancestor, but from different clades. Convergent evolution is the acquisition of the same trait in unrelated cultural lineages. For instance, a gradual process of cultural divergence and adaptive radiation has been proposed by Borrero (1989-1990) in Tierra del Fuego. Also Charlin et al. (2013), by using statistical techniques to the comparative study of the variability in the archaeological record, showed evidence of a process of cultural divergence between Tierra del Fuego and continental southern Patagonia. Convergent behavioral patterns often result from purely adaptive processes by which human groups respond in predictable ways confronting similar environmental pressures. Adaptive plasticity produces these phenomena in human behavior. Hence, Human Behavioral Ecology is a well informed theoretical framework for studying convergent evolution when the processes explaining the long term persistence of the environmentally induced convergences are considered.

In phylogenetic reconstruction, convergent evolution is a source of homoplasy, as well as parallelism and character reversals to an ancestral form. If the amount of homoplasy is high for a given dataset we say that the cultural dataset lacks a phylogenetic signal, given the absence of a cladistic (branching) structure in the dataset. Broadly, homoplasy is a character that is shared by multiple taxa due to some cause other than common ancestry (see Barrientos this volume). Hence, homoplasy documents other processes but not decent with modification. Another important source of homoplasy is horizontal cultural transfer. This happens when unrelated cultural lineages exchanges traits. For example, in Northwestern Argentina, during the Inca expansion, local ceramic traditions adopted traits from the Inca ceramic traditions. The results of these processes are reticulated phylogenies, such as those characterizing many plants and bacterial evolutionary history, where gene horizontal transfer is common. In these cases, the analytical research may consist in the documentation of the background pattern of decent with modification by removing these homoplasious traits from the dataset, and then to proceed exploring the reticulated phylogenies in order to gain information about the historical processes that produced them (Muscio 2011). At any rate, phylogenetic reconstruction should start with independent information about the homologous status of the variation.

Interestingly, as Cardillo and Charlin (2010, 2013) show, horizontal cultural transfer is a powerful way to reduce artifactual divergence. As the authors documented on broad spatial scales, the correlation between spatial and phylogenetic information is informative of gradients of morphological change in the projectile points of the mid-late Holocene. This pattern is causally linked to isolation by distance and to processes of information flow among populations. Both processes resulted in a low morphological divergence and parallelism in the evolutionary pathway of the projectile points of northern and southern Patagonia. On this basis the study of reticulated phylogenies is a necessary step towards illuminating the broad spatial processes of transmission that eroded cultural divergence. In addition, the patterns of spatial and temporal distribution of cultural lineages can document processes like population expansions or population extinctions. The phylogenetic analysis of datasets coming from large spaces can be useful to document cladistic patterns correlated with geography.

In this vein, the paper of Hernán Muscio, from a perspective based on population dynamics models the role of localized extinction in the cumulative evolution of cultural variation among subpopulations connected by migration. On this basis, it is suggested that group cultural differences may be lost as a consequence of a high rate of local extinction and migration. The analytical results are used to predict the archaeological patterns of representation of cultural lineages through time and space in ecological settings where localized extinction is frequent. By using cladistics, the author suggests that local extinction played an important role in the spread and evolution of cultural lineages among the earliest populations with economic niches based on high altitude agriculture in the northern puna of Argentina.

The processes of local extinction have received little attention by evolutionary archaeologists. Localized extinction is expected particularly during the colonization of new environments when individuals face unfamiliar environments. From a demographic point of view, smaller populations are more prone to local extinction by demographic stochasticity. From an ecological point of view, local extinction will be common in fluctuating environments and low quality habitats. An important question is the way in which local extinction occurs as the result of selection. This is called Darwinian extinction and takes place when a population under natural selection evolves along a path to extinction. For example, if optimizing selection leads to a increasing consumption of a small number of preys, a selective feedback between hunting behavior and a diminishing prey population can lead to the local extinction of the human population by the overhunting of its resource base. Hence, when we leave aside the adaptationist idea that phenotypic plasticity immunizes humans from the action of selection, we can study potential sources of past extinctions and potential mismatches between populations and their environments.

The paper by Diego Rivero and Matías Medina, based on the Human Behavioral Ecology approach, focuses on the consequences of the human colonization of the Sierras of Cordoba (Argentina) on the populations of high-ranked resources impacted by hunting pressures. The authors explore the long-term consequences of human induced reductions of high quality resource stocks for the evolution of broad-spectrum economic adaptations. Importantly, the authors conclude that a broad-spectrum diet may not have been an exclusively Late Holocene phenomenon and its origins may be found in earlier processes beginning during the Middle Holocene. Thus, the incorporation of small-scale agriculture around ca. 1200-1000 BP cannot be satisfactorily explained only by external factors such as climate changes or the diffusion and/or arrival of new biological populations. On this basis, Rivero and Medina call to consider the agency of past human cultural activities in process of niche construction, co-directing subsequent cultural changes that are archaeologically documented. Among the merits of this work it is the use of the rationale of the optimization models for illuminating long-term evolutionary processes, like niche construction.

In the same vein, Belardi et al. explore from a biogeographical framework the integration of several Darwinian approaches as we have shown previously. The authors focus on models of cultural transmission and particularly on niche construction (Odling-Smee 2003). On this basis cultural transmission is conceived as a key element in niche construction in large temporal and spatial scales. Based on the distributional patterns of rock art motif and considering its properties at broader spatial scales, the paper models important processes such as demographic evolution, mobility, and contact between groups. In this line, the authors show how the way in which human populations in Patagonia modified their environments by using rock art for cultural transmission and space signalling. In this way, the paper demonstrates the benefits of using different lines of evidence in order to discuss past evolutionary processes in archaeology.

Finally, as this book shows, Evolutionary Archaeology in Argentina is a consolidated field of research which during the last years has grown by the sophistication of its theoretical basis and the development of new methodologies for studying evolution in the archaeological record.We celebrate the way this intellectual tradition currently evolves in the Southern portion of América; the land that 150 years ago fuelled Darwin´s brilliant inspiration.

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