Toward a Theory of Recurrent Social Formations

Peter N. Peregrine

SFI WORKING PAPER: 2017-08-026

Toward a Theory of Recurrent Social Formations

Peter N. Peregrine, Lawrence University and the Santa Fe Institute

Abstract

The history of anthropology reflects a sometimes contentious dynamic between the study of unique cultural features and ones that are broadly shared across cultures, indeed so broadly shared that scholars have identified some as regularly recurring social formations. One aspect of the contention between these two areas of study is that the study of recurrent social formations has been marred by a history of ethnocentric perspectives and, more significantly, by a taxonomic approach lacking a general theory of cultural evolution. I demonstrate one way to remedy problems in the taxonomic approach by applying methods used in evolutionary biology to link the study of cultural variation to similar studies of phylogenetic variation. I employ Guttman scaling, morphospace analysis, and the exploration of adaptive landscapes to suggest a path toward a general theory of recurrent social formations.

Introduction

Social formations with remarkable similarities in social, political, and economic structures have emerged repeatedly throughout the history of the human species and in all areas of the globe. These recurrent social formations are thought to be the product of "general" evolutionary processes (*sensu* Sahlins 1960) that act upon human societies regardless of time or place, and have been the focus of anthropological research since the very beginning of the field (e.g. Tylor 1871: 1-14). An unfortunate consequence of early anthropologist's recognition of recurrent social forms was the linking of this observance with prevailing Eurocentric views of progress. Recurrent social formations were presented in the framework of a series of progressive "stages" through which all human societies progressed (or failed to progress) from, for example, "Savagery" to "Barbarism" to "Civilization" (Morgan 1877).

The theory of recurrent social formations being the product of a stair-like series of stages moving human societies towards an essentially European form was rejected by the turn of the 20th century, and nothing replaced it until the 1960s when anthropologists could no longer avoid the fact that an informal taxonomy of social types had emerged over the previous half-century which bore an uncanny resemblance to the stages proposed by earlier anthropologists (Sahlins 1960: 40-44; Steward 1955:178-185). Concern shifted to creating a formal taxonomy of cultural types (Steward 1955: 22-26; 87-92). This taxonomy took two forms, one focused on political economy: bands, tribes, chiefdoms and states (Service 1962); the other focused on social stratification: egalitarian, ranked, and stratified (Fried 1967). These two taxonomies are effectively identical if one removes tribes as a type (i.e., bands are egalitarian, chiefdoms are ranked, and states are stratified).

Problems with these taxonomies have been recognized from the time they were put forward (e.g. Service 1962:182), yet they have become embedded in anthropological thinking to the extent that scholars cannot seem to work without them (Bailey 1994:1). By way of example I present a quote, though in doing so I do not intend to demean the author's work; the quote simply demonstrates how ingrained these cultural taxonomies have become:

> It is certainly true that terms such as chiefdom can cause misunderstandings because they are associated with baggage acquired as their generally accepted use has changed over time. Despite the potential for confusion, the society centered on Cahokia is referred to here as a chiefdom, more precisely a complex chiefdom. (Milner, 1990:3)

Here a thoughtful scholar finds himself trapped into using a taxonomy he knows is flawed because he has no other conceptual framework to use when trying to explain to peers the similarities and differences between Cahokia and other social formations. And part of the problem in this specific case is that such explanations have historically degraded into a relatively unproductive taxonomic argument over whether Cahokia should be typed as a chiefdom or as a state. (In the quote above the author attempts to avoid the argument by saying it is neither—it is a different type, a "complex chiefdom." Obviously while this avoids the chiefdom versus state problem, it does not avoid the problem of being a taxonomic rather than explanatory argument.) The concept of chiefdoms as a cultural type has proven particularly thorny, as there is great variation among social formations defined as chiefdoms (Feinman and Neitzel 1984; Peebles and Kus 1977).

In recent years there has been much discussion about developing taxonomic approaches based on socio-political processes rather than political-economic or social traits (e.g. Blanton et al. 1996, Peregrine 2012). A problem with this approach is that it is still essentially a classificatory one rather than an explanatory one. If this approach is pursued, the taxonomic arguments do not drop away, but rather are transferred from traits to processes. The appeal is that processes can be explanatory, but the approach does not frame the effort in a directly explanatory manner.

What is needed, I suggest, is a broader theory to explain the presence and persistence of recurrent social formations. This theory would not in itself define those social formations, but rather would define processes out of which those recurrent formations arise. In other words, the processes are not intrinsic to the social formations themselves and are not what differentiate them from one another; rather, the processes are epigenetic and autopoietic, operating between and among social groups to shape them into similar formations (*sensu* Bourdieu 1977:72).

As a way to begin I consider three approaches to modeling evolutionary processes that provide both a means of clearly defining a taxonomy, and a general underlying theory to explain why such a taxonomy might (or might not) exist. While these methods do not translate directly into social theory, they do provide a clear pathway toward developing such theory. These approaches to modeling evolution are Guttman scaling, morphospace analysis, and the exploration of adaptive landscapes.

Data Sources

It is important to understand the data sources to be used in the analyses that follow, as they are somewhat unconventional. The unit of analysis here is the "archaeological tradition," defined as "a group of populations sharing similar subsistence practices, technology, and forms of socio-political organization, which are spatially contiguous over a relatively large area and which endure temporally for a relatively long period" (Peregrine 2001: iv). Minimal area coverage for an archaeological tradition can be thought of as something like 100,000 square kilometers; while minimal temporal duration can be thought of as something like five centuries. However, these figures are meant to help clarify the concept of an archaeological tradition, not to formally restrict its definition to these conditions. Archaeological traditions are artificial units of analysis, but are not arbitrary. They were designed to provide a unit that could be compared across broad regions and time scales. The sample of cases used here include all cases from the last 12,000 years listed in the *Outline of Archaeological Traditions* (Peregrine 2001), which is a comprehensive catalogue of archaeological traditions covering the entire globe for the last two million years.

The coded data themselves come from two primary sources: the *Atlas of Cultural Evolution* (Peregrine 2003) and additional variables on societal scale coded for the *Atlas* cases by researchers at the Santa Fe Institute (these are discussed in more detail in the chapter by Ortman, Blair, and Peregrine, this volume, and in Ortman et al. 2014). The *Atlas of Cultural Evolution* provides basic data on the evolution of cultural complexity for all cases in *Outline of Archaeological Traditions* sample. Data for the *Atlas* (i.e., the data used in this paper) were coded from entries in the *Encyclopedia of Prehistory* (Peregrine and Ember 2001-2002), a nine volume work providing summary information on all cases in the *Outline of Archaeological Traditions*. The base set of variables are ten Likert-scale variables created by Murdock and Provost (1973) for their scale of cultural complexity. These ten variables were recoded in two ways to better match the data available in the archaeological record. First, the individual traits measured through the 5-item Likert scales were recoded into 15 present–absent variables (Table 1). Second, the 5-item Likert scales were simplified into 3-item scales (Table 2; see Peregrine 2003 for details of the recoding procedure).

Two additional scale variables were constructed for the analyses presented here. Chick (1997) conducted a factor analysis on data coded for the Standard Cross-Cultural Sample and found two factors underlying the Murdock and Provost scale of cultural complexity. One reflects the technological capabilities of the society, while the other reflects the scale or size (in terms of population) of the society (Chick 1997). The variables that comprise each factor are shown in Table 3. These factor analysis-derived variables are employed here in the morphospace and adaptive landscape analyses. The recoded 3-item Likert scale variables were used to derive the factor scores for each archaeological tradition.

Methods

Guttman Scaling

Guttman scaling is a method for scaling items according to an underlying cumulative dimension (McIver and Carmines 1981:40). In a perfect Guttman scale, each item is cumulative in respect to the item below it on the scale; in other words, the presence of an item at the top of a Guttman scale indicates probabilistically that other traits lower on the scale are also present (Guttman

1950). A score of three on a given Guttman scale would, for example, indicate that items one, two, and three are all present, and that no other items in the scale are present.

Robert Carneiro (1962) suggested that Guttman scaling held great potential for the study of cultural evolution because it identifies a clear hierarchy among a group of scale items. There are obvious evolutionary implications if one finds that a group of traits form a Guttman scale, as “the order in which the traits are arranged, from bottom to top, is [probabilistically] the order in which the societies have evolved them” (Carneiro 1970:837; also see Gell-Mann 2011). Guttman scaling provides a method for modeling cultural evolution because the hierarchy of cultural traits inherent in a Guttman scale suggests an evolutionary order.

Peregrine, Ember, and Ember (2004) demonstrated that the 15-item version of the Murdock-Provost scale of cultural complexity forms a Guttman scale in the order with which the individual variables are presented in Table 1. According to this scale, the presence of status or wealth differences within a given society also indicates that the society is sedentary, has domesticated plants or animals, and produces ceramics. The implication of this scale is that there is at least one unidimensional evolutionary process at work to create this hierarchy.

Figure 1 presents scalograms based on this scale for eight regional cultural evolutionary sequences. The sequences provide an empirical picture of cultural change over time that supports the Guttman scale. But there is also an interesting pattern of jumps in which several scale items appear together. Indeed the pattern appears to be fairly regular in several ways. First, there seem to be similar rapid leaps from societies having none of the traits to having agriculture and/or villages, implying that these traits appear together or in rapid succession. There appears a second common leap to a state form of government, with intervening traits appearing together or in train.

The step-like rather than smooth accumulation of traits suggests that the unidimensional process underlying the Guttman scale is not uniform in its effects. Rather, traits often appear in clusters or groups, an effect modeled in the dendrogram presented as Figure 2. It is interesting that these clusters of traits map onto existing typologies of recurrent social formations. Cluster A is similar to what are commonly called chiefdoms—sedentary, inegalitarian but non-state societies. Cluster B encompasses states, some large and bureaucratic (Cluster D), some smaller and lacking scribes, money, and other elements of bureaucracy (Cluster C).

The Guttman scale analyses thus suggests that recurrent social formations may be the result of a step-like or punctuated process in which a critical state is reached followed by a transformation, or, alternatively, that intermediate states are unstable. The transformed states are relatively stable and appear as recurrent social formations, although each evolves independently through the same transitive process. I suggest that what we see as recurrent social formations are not "stages" of development or societal "types", but rather are the results of an autopoietic process of convergent evolution acting across societies through time. I explore this idea further in the next section.

Theoretical and Empirical Morphospaces

One way to explore the boundaries or limits of convergent evolution is through the analysis of theoretical and empirical morphospaces. A morphospace is an N-dimensional space constructed from morphological variables for a given species or other taxon. A theoretical morphospace is produced using variables that are thought to be important in understanding the range of variation within a particular taxon. These variables make up the morphospace's dimensions, and represent the complete range of possible forms along these dimensions (McGhee 2007:57-61). An empirical morphospace maps known cases onto the morphospace to identify the range of actual forms in existence. The absence of forms in a particular area of a morphospace suggests regions that are either impossible or unsuccessful (McGhee 2007:72-75).

Morphospace analysis was developed by Raup (1966) who used the method to demonstrate that species with coiled shells, because of the physical parameters of coiling, are limited in the range of possible morphospaces within which they can exist. This is considered an architectural or geometric limitation. Functional or adaptive limitations can also be found, for example, Chamberlain (1976) argued that the empirical range of ammonoid morphospace was limited because of the need for efficient swimming. Inefficient forms died out, and thus the empirical range of ammonoid forms is far smaller than the theoretical range. It is this ability to explore the functional or adaptive significance of the variation between empirical and theoretical morphospaces that makes it a particularly valuable tool for examining evolution (see also Atkinson and Whitehouse 2011).

Figure 3 presents a two-dimensional morphospace for the two variables derived by factor analysis from the Murdock and Provost scale of cultural complexity (Chick 1997). As presented in Figure 3, the Technology Factor is the Y-axis and the Scale Factor the X-axis. One would assume that in empirical morphospace societies would be randomly distributed, but this is obviously not the case. High scale, low technology societies are essentially absent (Region 2), as are very low scale, high technology societies (Region 1). It would appear that technology and scale place constraints on one another in such a way that a particular scale is required to support a particular technological capabilities or vice-versa. Figure 4 demonstrates these constraints diachronically. Both scale and technology evolve together, filling in the morphospace in a roughly linear pattern which avoids both high scale low technology and low scale high technology realms. There appears to be interdependence between scale and technology such that neither can grow without the other growing in roughly parallel fashion. The evaluation of developmental and functional constraints should provide a way of understanding both the empty regions and the relationship between scale and technology.

Functional constraints refer to forms that cannot exist because they are "lethal" to individuals of the given taxon—these forms simply do not function successfully (McGhee 2007:111). The primary functional constraint for Region 1 may be the need for a sufficient population to construct, operate, and maintain more complex and diverse technologies; that is, with a small population there are not enough people to share the time and expertise needed to maintain a complex technological regime. For Region 2, it seems likely that complex technologies are required to support a large population. Simple technologies cannot produce sufficient food, clothing, housing, and other resources for a large population.

Developmental constraints refer to forms within a given taxon that cannot exist because they lack the features necessary to produce specific forms (McGhee 2007:114). Following the work of Brian Arthur (2009) I hypothesize that with a small population there may not be sufficient "minds" to develop new technologies. According to Arthur (2009), technological innovations primarily grow through the combination of existing "modules". If there are not enough interacting "minds" with knowledge of these "modules" to provide opportunities for combination, then new technology will not develop. It is only when the size of the interacting "minds" is large enough that technological evolution can fully emerge. In the case of Region 2, it seems well established that technology is cumulative, and that retrogression toward simpler technologies is rare in human societies (e.g. Tomasello 2001). Thus, as more complex technology develops, we would expect it to continue to evolve.

The discussion of developmental and functional constraints provides a useful path toward understanding the empty regions in the Figure 3 morphospace, but it does little to aid our understanding of the regions where cultures appear clustered. The chapter in this volume by Ortman, Blair and myself provide some additional ideas about how scalar efficiencies might produce regularities in social formations. But as I noted earlier that these regions may represent the effect of convergent evolution. McGhee (2007:93-96) suggests that the exploration of adaptive landscapes offers an excellent method for examining this process, and I evaluate this suggestion in the next section.

Adaptive Landscapes

Wright (1932) developed the idea of adaptive landscapes as part of his seminal approach to understanding natural selection through the lens of genetic fitness. An adaptive landscape, like that presented in Figure 8, can be interpreted as representing the relative fitness of particular genetic variations. Peaks are regions with high fitness, while valleys are regions of low fitness. It is assumed that organisms evolve through moving from regions of low fitness to those of high fitness, in essence, climbing to peaks in the adaptive landscape. In Wright's model, convergent evolution is expected to occur regularly as different organisms move towards the same peak (McGhee 2007: 33-36).

Convergence is thought to occur because there are limited ways of adapting to any particular environment, so similar species in a given environment will all eventually converge (McGhee 2011). Humans, however, shape our own environments, particularly after the adoption of agriculture (Smith 2007). We are niche constructors and environmental engineers; the environments we live in are (at least partially) our own creations (Laland and O'Brien 2011). Cultural innovations that we use to engineer the environment can lead to new opportunities and, in the context of adaptive landscapes, new adaptive peaks (e.g. Erwin 2008).

Indeed, humans have been called "the ultimate niche constructors" (Odling-Smee, Laland, and Feldman 2003:28) as a primary focus of cultural adaptations have been, at least since the emergence of agriculture, the active manipulation or engineering of the environment to create more stable or suitable conditions for agriculture (Smith 2007:197). As we create these new environments, we in turn provide a new environmental context that is inherited by descendants and by neighboring societies (Odling-Smee, Laland, and Feldman 2003: 2-16, 27, 252). Thus human niche construction produces not simply adaptive peaks, but rather adaptive *attractors* that draw other societies towards them. This process of niche construction, ecological inheritance, and adaptive attraction is, I suggest, the source of recurrent social formations.

Figure 5 is a transformation of the empirical morphospace presented in Figure 3 into a three-dimensional adaptive landscape. Three adaptive peaks are clearly visible. The first, and largest, is at the origin of the landscape, where societies are small scale and have low technology. This represents the basic hunting-and-gathering adaptation upon which humans evolved and which remained a basic way of life for most humans until quite recently. A second peak reflects the societies of Cluster A—sedentary, agricultural, and inegalitarian but non-state. These reflect the creation of a new adaptive peak based on agriculture.

Looking at Figure 6, which presents the adaptive landscapes diachronically, we can see the emergence of the Cluster A adaptive peak, and the convergence of many societies upon it. The peak first appears between 10,000 and 12,000 years ago. Between 8000 and 10,000 years ago there is divergence among newly agricultural societies, creating ripples in the adaptive landscape. Between 6000 and 8000 years ago a new peak rapidly emerges as societies converge on the recurrent social formation identified here as Cluster A.

Between 2000 and 4000 years ago, however, the Cluster A adaptive peak itself begins to diversify, and a more rugged adaptive landscape appears in its environs. If this were occurring among a group of animal species, one would suggest that the development of greater morphological variety led to disruptive selection and/or that the new variations have created conflicting morphological or physiological constraints (McGhee 2007:15-21). I suggest this is precisely what occurred with the development of agriculture. As agricultural lifestyles spread into new environments, and societies faced the emerging challenges of sedentary life, variations with conflicting constraints appeared, reflected here in a rugged adaptive landscape.

One of those new variations was the new peak that emerges between 2000 and 4000 years ago—a new peak representing the simple states of Cluster C. Looking closely at the adaptive landscape for this period, one notices a long ridge connecting the Cluster A and Cluster C peaks. This ridge represents societies of increasing scale, and I suggest captures the evolutionary movement of societies converging on the new Cluster C peak. If we were able to move the adaptive landscape forward another 1000 years (the data prevent us from doing so), we should see the Cluster C peak continuing to grow, and the Cluster A peak continuing to decline. Were we to look at an adaptive landscape of societies today, we would find a "Fujiyama" landscape with one large peak encompassing virtually all societies, and focused on what is only a small hill at the very top right of the 2000 to 4000 year ago landscape—the complex states of Cluster D.

Toward a Theory of Recurrent Social Formations

The history of anthropology reflects an often contentious dynamic between the study of unique cultural features and ones that are broadly shared across cultures (Carneiro 2003). The latter study has been marred by a history of ethnocentric perspectives and, more significantly, by a taxonomic approach lacking a general theory of cultural evolution. I have proposed one means to remedy problems in the taxonomic approach by applying methods used in evolutionary biology, thus linking the study of cultural variation to similar studies of phylogenetic variation (see also Currie 2013; Lipo et al. 2006; O'Brien et al. 2008). The methods of evolutionary biology provide a path toward a taxonomic approach to recurrent social formations that is both theoretically based and empirically robust (see also Mesoudi, Whiten and Laland 2006; O'Brien and Lyman 2000).

I am certainly not the first to suggest that the methods of evolutionary biology should play a larger role in archaeological research, but I do suggest that the work presented here is distinct in demonstrating, both *empirically* and *systematically*, the importance of comparative archaeology to understanding cultural evolution. Specifically, I have shown that large-scale comparative analyses of the archaeological record can be analyzed in the same way as large-scale comparative data on biological organisms. This comparative method is relatively rare in archaeology, where case studies are far more common, and almost non-existent in the diachronic form employed here. Beyond that simple methodological insight, I have demonstrated *empirically* the presence of recurrent social formations which appear very similar to those put forward by anthropologists more than half a century ago. It is important to note that these recurrent social formations emerged from the analyses, not from *a priori* coding criteria or theory. They are, quite simply, present in the data (Sabloff and Craig demonstrate a similar phenomenon in their chapter in this volume). The question remains, what processes create these recurrent social formations?

I have suggested that recurrent social formations are the result of convergent evolution in an adaptive landscape with several major peaks. These peaks reflect stable adaptations within particular physical and, more importantly, cultural environments (see also Laland and O'Brien 2010:308). But in understanding the appearance and nature of these peaks it is essential to recognize that humans are the quintessential environmental engineers. Cultural innovations (such as agriculture) are niche constructors, effectively shaping the adaptive landscape. These innovations also create conflicting constraints, leading to diversity in specific adaptive forms. Thus recurrent social formations are not identical, but reflect the unique historical trajectory of societies as they are attracted towards specific adaptive peaks.

In closing I return to the issue with which I opened this paper—the issue of cultural taxonomy. Anthropology has long recognized that there are social formations that seem to recur, but there has been considerable controversy over how to identify and define, or even whether to identify and define, these recurrent social formations. I have illustrated an approach to this issue which appears to have identified inductively the presence of at least three recurrent social formations that have evolved within the last 10,000 years. This simple finding provides empirical evidence that the two most widely used cultural taxonomies—those of Fried and Service—represent, at least in a broad context, social reality. Thus I argue that work employing "traditional" cultural taxonomies—including work done by the Santa Fe Institute exploring the origins of states—has used appropriate concepts and should not be criticized out of hand for using those "traditional" taxonomic units.

Acknowledgements

This paper was born during a discussion with Doug Erwin about morphospace analysis, and grew through the influence of many conversations in the stimulating environment of the Santa Fe

Institute. I want to thank the many colleagues at the Santa Fe Institute who pointed me in fruitful directions and helped me to refine my ideas. I also want to thank George McGhee for his useful input, particularly on the concept of convergent evolution. Doug Erwin and George McGhee read an early version of this paper and for that I again thank them. Parts of this paper were presented at the 2014 meetings of the American Anthropological Association and the Society for Anthropological Sciences, as well in colloquia at the Santa Fe Institute. This work was supported by a grant from the John Templeton Foundation to the Santa Fe Institute.

References Cited

Arthur, W. Brian. 2009. *The nature of technology: What it is and how it evolves*. New York: Free Press.

Atkinson, Quentin and Harvey Whitehouse. 2011. The cultural morphospace of ritual form: Examining modes of religiosity cross-culturally. *Evolution and Human Behavior* 32:50-62.

Bailey, Kenneth. 1994. *Typologies and taxonomies: An introduction to classification techniques*. Thousand Oaks, CA: Sage.

Blanton, Richard, Gary Feinman, Stephen Kowlewski, and Peter N. Peregrine. 1996. A dual-processual theory for the evolution of Mesoamerican civilization. *Current Anthropology* 37:1-14.

Bourdieu, Pierre. 1977. *Outline of a theory of practice*, trans. Richard Nice. Cambridge: Cambridge University Press.

Carneiro, Robert. 1962. Scale analysis as an instrument for the study of cultural evolution. *Southwestern Journal of Anthropology* 18:149–169.

Carneiro, Robert. 1970. Scale analysis, evolutionary sequences, and the rating of cultures. In *A handbook of method in cultural anthropology*. Raoul Naroll and Ronald Cohen, eds. Pp. 834–871. Garden City, NY: Natural History Press.

Carneiro, Robert. 2003. *Evolutionism in cultural anthropology: A critical history*. Boulder, CO: Westview Press.

Chamberlain, John. 1976. Flow patterns and drag coefficients of Cephalopod shells. *Paleontology* 19:539-563.

Chick, Gary. 1997. Cultural complexity: The concept and its measurement. *Cross-Cultural Research* 31:275-307.

Currie, Thomas. 2013. Cultural evolution branches out: The phylogenetic approach in cross-cultural research. *Cross-Cultural Research* 47:102-130

Erwin, Douglas. 2008. Macroevolution of ecosystem engineering, niche construction and diversity. *Trends in Ecology and Evolution* 23:304-310.

Feinman, Gary and Jill Neitzel. 1984. Too many types: An overview of sedentary prestate societies in the Americas. *Advances in Archaeological Method and Theory* 7:39-102.

Foote, Michael. 1990. Nearest-neighbor analysis of Trilobite morphospace. *Systematic Zoology* 39:371-382.

Fried, Morton. 1967. *The evolution of political society: An essay in political anthropology*. New York: Random House.

Gell-Mann, Murray. 2011. Regularities in human affairs. *Cliodynamics* 2:52-70.

Guttman, Louis. 1950. The basis for scalogram analysis. In *Measurement and prediction*. Samuel A. Stouffer, ed. Pp. 60–90. Princeton: Princeton University Press.

Laland, Kevin and Michael O'Brien. 2010. Niche construction theory and archaeology. *Journal of Archaeological Method and Theory* 17:303-322.

Laland, Kevin and Michael O'Brien. 2011. Cultural niche construction: An introduction. *Biological Theory* 6:191-202

Lipo, Carl, Michael O'Brien and Stephen Shennan, eds. 2006. *Mapping our ancestors: Phylogenetic methods in anthropology and prehistory*. New Brunswick, NJ: Aldine

McGhee, George. 2007. *The geometry of evolution: Adaptive landscapes and theoretical morphospaces*. Cambridge: Cambridge University Press.

McGhee, George. 2011. *Convergent evolution: Limited forms most beautiful*. Cambridge: MIT Press.

McIver, John and Edward Carmines. 1981. *Unidimensional scaling*. Thousand Oaks, CA: Sage.

Mesoudi, Alex, Andrew Whiten and Kevin Laland. 2006. Towards a unified science of cultural evolution. *Behavioral and Brain Sciences* 29:329-347.

Milner, George. 1991. *The Cahokia chiefdom*. Washington: Smithsonian.

Morgan, Lewis Henry. 1877. *Ancient society*. New York: Henry Holt.

Murdock, George and Catherine Provost. 1973. Measurement of cultural complexity. *Ethnology* 12:379-392.

O'Brien, Michael and R. Lee Lyman. 2000. *Applying evolutionary archaeology: A systematic approach.* New York: Springer.

O'Brien, Michael, R.L. Lyman, M. Collard, C.J. Holden, R.D. Gray and S.J. Shennan. 2008. Phylogenetics and the evolution of cultural diversity. In M.J. O'Brien, ed. *Cultural transmission and archaeology,* pp 39-58. Washington, DC: Society for American Archaeology

Odling-Smee, John, Kevin Laland and Marcus Feldman. 2003. *Niche construction: The neglected process in evolution.* Princeton: Princeton University Press.

Ortman, Scott, Andrew Cabaniss, Jennie Sturm and Luis Bettencourt. 2014. The pre-history of urban scaling. *Plos One* 9(2): e87902. doi:10.1371/journal.pone.0087902

Peebles, Christopher and Susan Kus. 1977. Some archaeological correlates of ranked societies. *American Antiquity* 42:421-448.

Peregrine, Peter. 2001. *Outline of archaeological traditions*. New Haven: HRAF Press.

Peregrine, Peter. 2003. Atlas of cultural evolution. *World Cultures* 14(1):2–88.

Peregrine, Peter, Carol Ember and Melvin Ember. 2004. Universal patterns in cultural evolution: An empirical analysis using Guttman scaling. *American Anthropologist* 106(1):145-149.

Peregrine, Peter and Melvin Embef, eds. 2001-2002. *Encyclopedia of prehistory*, 9 vols. Nre York: Kluwer Academic / Plenum Publishers.

Raup, Donald. 1966. Geometric analysis of shell coiling: General problems. *Proceedings of the National Academy of Sciences* 47:602-609.

Sahlins, Marshall. 1960. Evolution: Specific and general. In *Evolution and culture*, Marshall Sahlins and Elman Service, eds, pp 12-44. Ann Arbor: University of Michigan Press.

Service, Elman. 1962. *Primitive social organization: An evolutionary perspective*. New York: Random House.

Smith, Bruce. 2007. Niche construction and the behavioral context of plant and animal domestication. *Evolutionary Anthropology* 16: 188-199.

Steward, Julian. 1955. *Theory of culture change: The methodology of multilinear evolution*. Urbana: University of Illinois Press.

Tomasello, Michael. 2011. Human culture in evolutionary perspective. *Advances in Culture and Psychology* 1: 5-51.

Tylor, Edward Burnett. 1871. *Primitive culture: Researches into the development of mythology, philosophy, religion, art, and custom*. London: John Murray.

Wright, Sewall. 1932. The roles of mutation, inbreeding, crossbreeding and selection in evolution. *Proceedings of the Sixth International Congress of Genetics* 1:356-366.

Table 1: 15-Item Murdock-Provost Scale of Cultural Complexity, from Peregrine (2003). These are present-absent variables based upon key indicators of cultural complexity as defined by Murdock and Provost (1973) and were demonstrated to form a Guttman Scale in the order presented here (Peregrine, Ember and Ember (2004).

1. Ceramic production
2. Presence of domesticates
3. Sedentarism
4. Inegalitarian (status or wealth differences)
5. Density > 1 person/mi2 specialists
6. Reliance on food production
7. Villages > 100 persons
8. Metal production
9. Social classes present
10. Towns > 400 persons population
11. State (3+ levels of hierarchy)
12. Density > 25 persons/mi2
13. Wheeled transport
14. Writing of any kind
15. Money of any kind

Table 2: Murdock-Provost Scale of Cultural Complexity as recoded by Peregrine (2003). The original 5-item Likert scale variables were transformed into 3-item scales to make them easier to code with archaeological data.

Scale 1: Writing and Records

1 = None

2 = Mnemonic or nonwritten records

3 = True writing

Scale 2: Fixity of Residence

1 = Nomadic

2 = Seminomadic

3 = Sedentary

Scale 3: Agriculture

1 = None

2 = 10% or more, but secondary

3 = Primary

Scale 4: Urbanization (largest settlement)

1 = Fewer than 100 persons

2 = 100--399 persons

3 = 400+ persons

Scale 5: Technological Specialization

1 = None

2 = Pottery

3 = Metalwork (alloys, forging, casting)

Scale 6- Land Transport

1 = Human only

2 = Pack or draft animals

3 = Vehicles

Scale 7- Money

1 = None

2 = Domestically usable articles

3 = Currency

Scale 8- Density of Population

1 = Less than 1 person/square mile

2 = 1--25 persons/square mile

3 = 26+ persons/square mile

Scale 9- Political Integration

1 = Autonomous local communities

2 = 1 or 2 level above community

3 = 3 or more levels above community

Scale 10- Social Stratification

1 = Egalitarian

2 = 2 social classes

3 = 3 or more social classes or castes

Table 3: Underlying factors in the Murdock-Provost Scale of Cultural Complexity, as identified by Chick (1997). The variables comprising the two factors are listed in the order in which they loaded upon each factor. The Technology factor explains 52.8% of the total variance while the Scale Factor explains 14.5%. Individual variable loadings are shown in parentheses.

Technology Factor	Scale Factor
Scale 1: Writing and Records (0.848)	Scale 2: Fixity of Residence (0.918)
Scale 6- Land Transport (0.846)	Scale 3: Agriculture (0.849)
Scale 10- Social Stratification (0.716)	Scale 8- Density of Population (0.824)
Scale 9- Political Integration (0.669)	Scale 4: Urbanization (0.542)
Scale 5: Technological Specialization (0.606)	
Scale 7- Money (0.578)	

Figure 1: Scalograms for eight regional cultural-evolutionary sequences, from Peregrine, Ember and Ember (2004). Columns represent individual archaeological traditions from the *Atlas of Cultural Evolution* (Peregrine 2003) with their identification numbers at the bottom of the column. An X represents a match between the Guttman scale and the archaeological record, a ? represents the absence of an expected scale item.

Yellow River Valley	4005	4015	4025	4030	4055	4060
Money						
Writing						X
Wheel						X
Density>25						?
State					X	X
Towns>400					X	X
Classes					X	X
Metals					X	X
Villages>100			X	X	X	X
Agriculture		X	X	X	X	X
Density>1		X	X	X	X	X
Inegalitarian		X	X	X	X	X
Sedentarism		X	X	X	X	X
Domesticates		X	X	X	X	X
Ceramics		X	X	X	X	X

Indus River Valley	5505	5515	5530	5535	5555
Money				X	X
Writing				X	X
Wheel				X	X
Density>25			X	X	X
State			X	X	X
Towns>400			X	X	X
Classes			X	X	X
Metals			X	X	X
Villages>100		X	X	X	X
Agriculture		X	X	X	X
Density>1		X	X	X	X
Inegalitarian		X	X	X	X
Sedentarism		X	X	X	X
Domesticates		X	X	X	X
Ceramics		X	X	X	X

Nile River Valley	7040	6110	6115	6125	6130	6135
Money					X	X
Writing					X	X
Wheel					X	X
Density>25					X	X
State					X	X
Towns>400					X	X
Classes					X	X
Metals					X	X
Villages>100					X	X
Agriculture			X	X	X	X
Density>1			X	X	X	X
Inegalitarian			X	X	X	X
Sedentarism			X	X	X	X
Domesticates			X	X	X	X
Ceramics			?	?	X	X

Mesopotamia	6205	6215	6220	6245	6250	6255	6260	6265	6270
Money				X	X	X	X	X	X
Writing				X	X	X	X	X	X
Wheel				X	X	X	X	X	X
Density>25				X	X	X	X	X	X
State				X	X	X	X	X	X
Towns>400				X	X	X	X	X	X
Classes				X	X	X	X	X	X
Metals				X	X	X	X	X	X
Villages>100		X	X	X	X	X	X	X	X
Agriculture		X	X	X	X	X	X	X	X
Density>1		X	X	X	X	X	X	X	X
Inegalitarian		X	X	X	X	X	X	X	X
Sedentarism		X	X	X	X	X	X	X	X
Domesticates		X	X	X	X	X	X	X	X
Ceramics		?	X	X	X	X	X	X	X

West Africa	6175	6180	6185	6190
Money				
Writing				
Wheel				
Density>25				
State				X
Towns>400				X
Classes				X
Metals			X	X
Villages>100			X	X
Agriculture		X	X	X
Density>1		?	X	X
Inegalitarian		X	X	X
Sedentarism		?	X	X
Domesticates		X	X	X
Ceramics		X	X	X

Highland Peru	2205	2215	2225	2235	2250	2260	2275
Money							
Writing							
Wheel							
Density>25							
State				X	X	X	X
Towns>400			X	X	X	X	X
Classes			?	X	X	X	X
Metals			?	X	X	X	X
Villages>100		X	X	X	X	X	X
Agriculture		?	X	X	X	X	X
Density>1		?	X	X	X	X	X
Inegalitarian		?	X	X	X	X	X
Sedentarism		X	X	X	X	X	X
Domesticates		X	X	X	X	X	X
Ceramics		?	X	X	X	X	X

Lowland Mesoamerica	1505	1512	1522	1550	1560
Money					
Writing				X	X
Wheel				?	?
Density>25				?	?
State				X	X
Towns>400			X	X	X
Classes			?	X	X
Metals			?	X	X
Villages>100			X	X	X
Agriculture			X	X	X
Density>1			X	X	X
Inegalitarian			X	X	X
Sedentarism			X	X	X
Domesticates		X	X	X	X
Ceramics		?	X	X	X

Highland Mesoamerica	1505	1510	1515	1520	1540	1570
Money						
Writing						X
Wheel						?
Density>25						?
State					X	X
Towns>400				X	X	X
Classes				?	X	X
Metals				?	X	X
Villages>100			X	X	X	X
Agriculture			X	X	X	X
Density>1			X	X	X	X
Inegalitarian			X	X	X	X
Sedentarism			X	X	X	X
Domesticates		X	X	X	X	X
Ceramics		?	X	X	X	X

Figure 2: Ward's method dendrogram based upon the eight cultural evolutionary sequences presented in Figure 1, from Peregrine, Ember and Ember (2004).

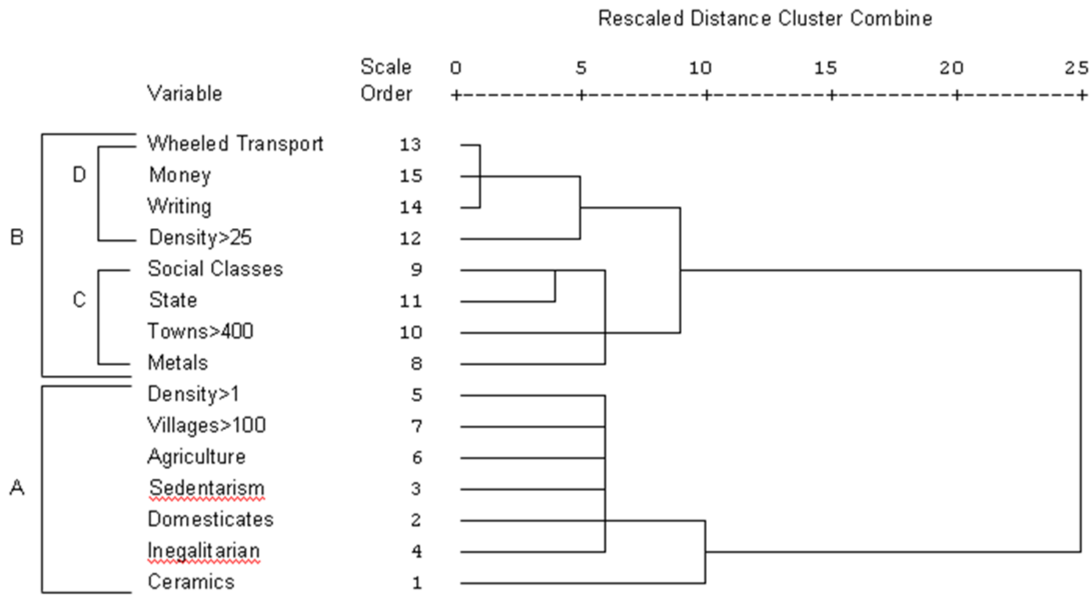

Figure 3. Empirical morphospace of cultural complexity for cases in the *Atlas of Cultural Evolution* (Peregrine 2003) dated from the last 12,000 years. The x-axis is the Scale Factor, the y-axis is the Technology Factor (see Table 3); the size of the dots indicates the number of cases. The dashed lines demarcate two regions where empirical cases are extremely rare. The cases within Region A are all pastoralists who obtained metals and other sophisticated technologies through interaction with larger sedentary societies.

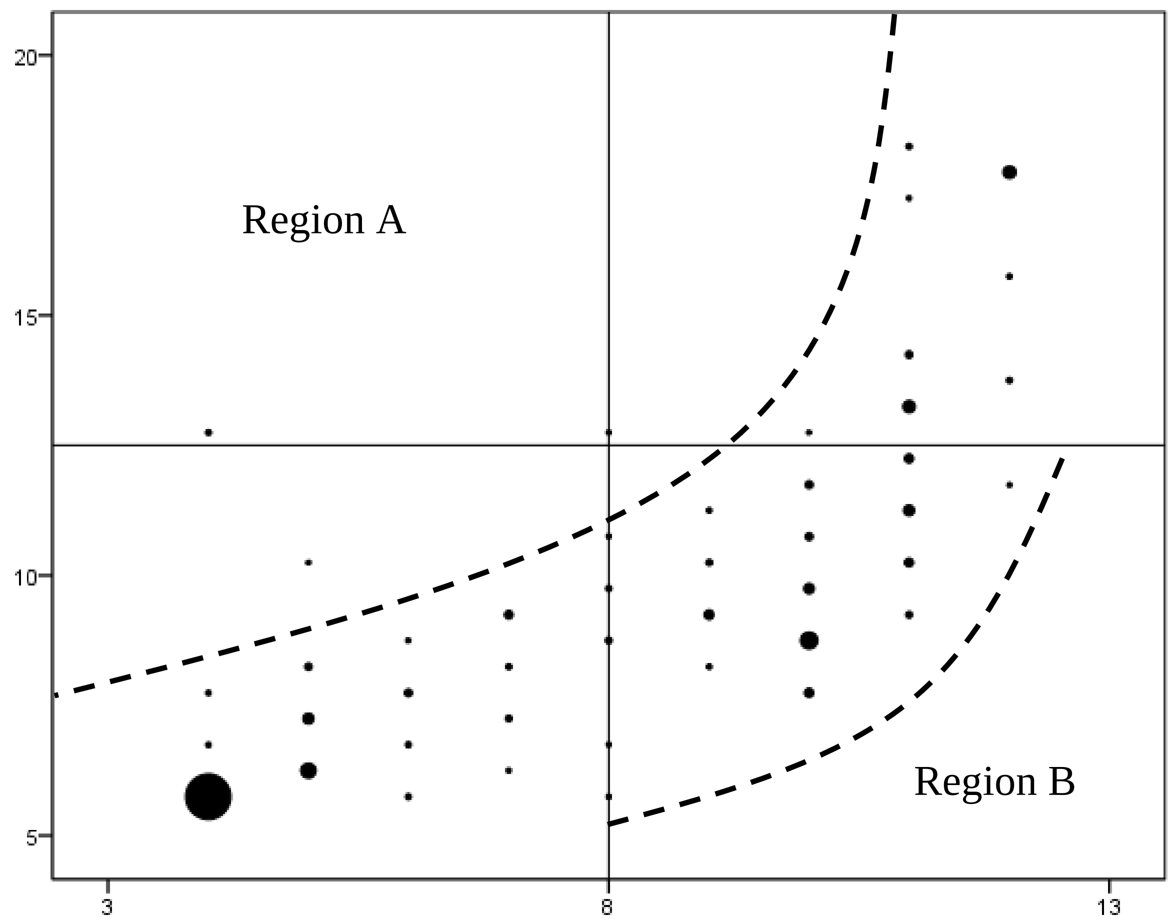

Figure 4. Empirical morphospace of societal scale and technology in 2000 year intervals from 12,000 to 2000 years ago. Size of dots indicates the number of cases.

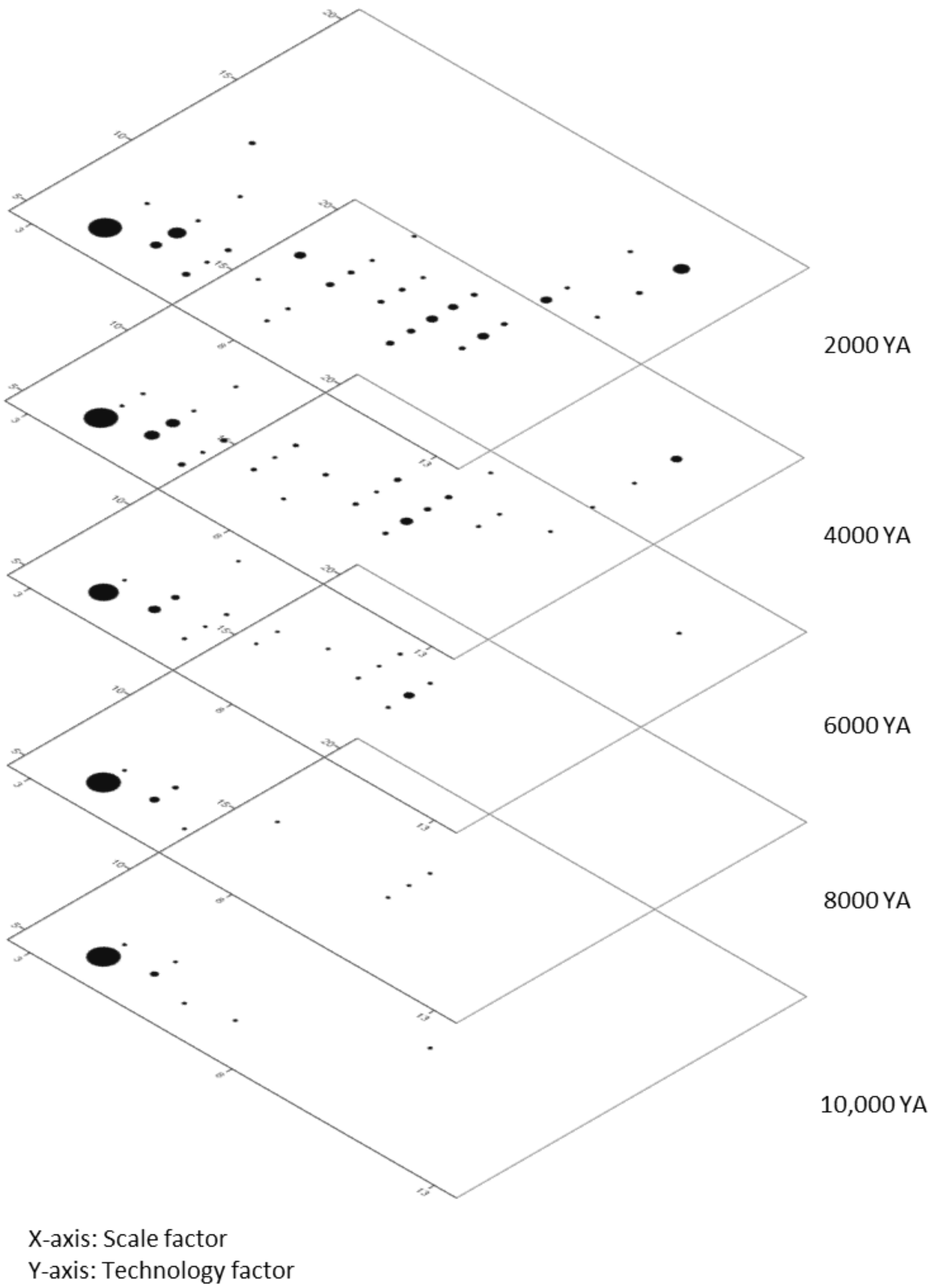

Figure 5: The empirical morphospace of Figure 3 displayed as a contour map. This map can be interpreted as an adaptive landscape.

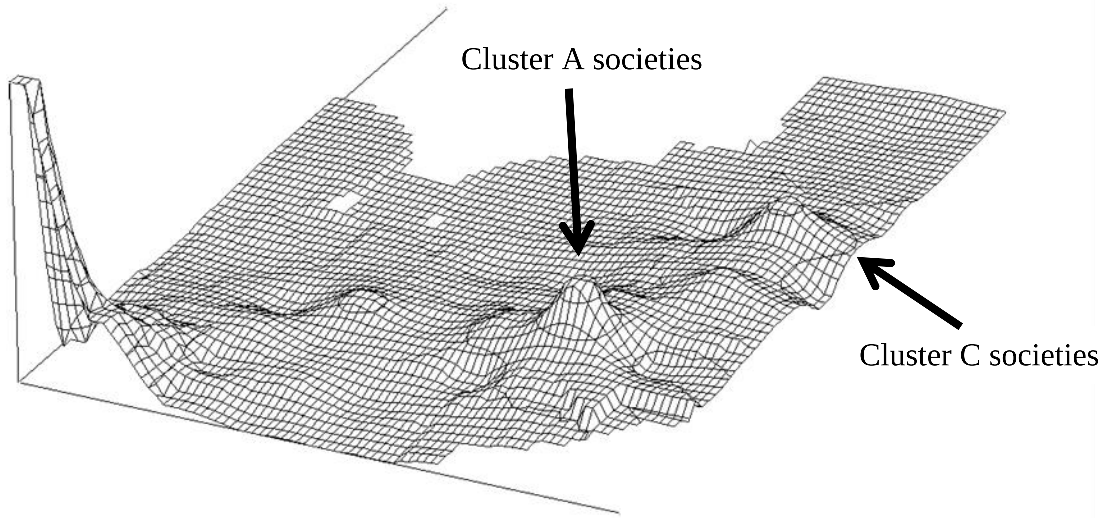

Figure 6: The empirical morphospaces of Figure 4 displayed as contour maps, and interpreted as representing adaptive landscapes.