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J. Patrick Gray, Editor

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Contents And How To Use This Issue

This entire issue of WORLD CULTURES is devoted to Peter Peregrine's *Atlas of Cultural Evolution*. The *Atlas* is a major resource for archaeoethnological research. The data are on the accompanying CD in the ACE.SAV SPSS file. The CD also contains the *MapMaker Gratis* program discussed in Peregrine's article. The compressed file mmZip.exe is in the \Map subdirectory of the CD, along with the data files needed to reproduce the maps in the article.

---*J. Patrick Gray*

2003 World Cultures 14(1): 2-88 http://eclectic.ss.uci.edu/Archaeo/14-1a-peregrine.pdf
Part B: **Live link to** http://eclectic.ss.uci.edu/Archaeo/14-1b-peregrine.pdf

Atlas of Cultural Evolution

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The Atlas of Cultural Evolution provides basic data on the evolution of cultural complexity using the Outline of Archaeological Traditions sample. The Outline of Archaeological Traditions constitutes a sampling universe from which cases can be drawn for diachronic cross-cultural research, an activity I refer to as archaeoethnology. Data for the Atlas were drawn from entries in the Encyclopedia of Prehistory, a nine volume work providing summary information on all cases in the Outline of Archaeological Traditions, thus the Atlas also demonstrates the utility of the Encyclopedia of Prehistory as a basic tool for archaeoethnology. I suggest that a more sophisticated tool for archaeoethnology, the eHRAF Collection of Archaeology, be used to further test and refine the cultural evolutionary trends put forward here.

1. ARCHAEOETHNOLOGY

Comparative research is a necessary tool in evolutionary science. It is only through comparison that we can identify diversity, and it is the creation and maintenance of diversity that evolutionary science attempts to understand. Within anthropology, comparative research is usually called cross-cultural research or ethnology.

The unit of analysis in such research is the culture. What constitutes a culture is rather loosely defined, but includes sharing a common language, a common economic and socio-political system, and some degree of territorial continuity. Because any given population within a culture will show some divergence from the others, a culture is usually represented by a particular community, and because cultures are always changing, the representative or focal community is described as of a particular point in time.

Cross-cultural research makes two fundamental assumptions. First, that a culture can be adequately represented by a single community. And second, that cultures can be compared. The first assumption is based on the idea that any definition of culture will be broad enough that any given community in a culture will share fundamental features of behavior and organization with others similarly defined. The second is based on the uniformitarian assumption underlying all evolutionary science: if an explanation accurately reflects reality, "measures of the presumed causes and effects should be significantly and strongly associated synchronically" (Ember and Ember 1995:88).

Archaeoethnology attempts to extends traditional cross-cultural research in two dimensions. First, it attempts to add new cases to those which can be used for comparison, and hence increases the sample size for cross-cultural research (but see section 1.C below). Second, and perhaps more importantly, archaeoethnology attempts to provide a way to determine whether the presumed cause of some phenomenon actually precedes its presumed effects. Like all forms of comparative research, archaeoethnology seeks to identify regular associations between variables and to test explanations for why those associations exist. Unlike ethnology using extant or recent cultures, the associations identified through archaeoethnology can be either synchronic or diachronic, and the explanations for them can be tested both synchronically and diachronically.

Because of its ability to identify and test explanations diachronically, archaeoethnology is uniquely suited to exploring both unilinear and multilinear trends in cultural evolution. Unilinear trends refer to either progressive or regressive changes in societal scale, complexity, and integration that take place over a long period of time and large geographical areas. Archaeoethnology can examine change over a long period of time to determine empirically whether unilinear trends are present, and test explanations for those trends by determining whether presumed causes actually precede presumed effects. Similarly, multilinear evolutionary processes, those that create the specific features of different societies within the larger, unilinear trends, can be tested diachronically to see if presumed causes precede assumed effects. Such research is perhaps best carried out using the eHRAF Collection of Archaeology.

The diachronic nature of archaeoethnology also makes it uniquely suited to exploring patterns of migration, innovation, and diffusion, and to investigating the roles of these processes in cultural evolution. A synchronic study of a given region might suggest that a trait diffused through cultures in a region, and perhaps might suggest the source and path of the diffused trait. Only a diachronic study can demonstrate diffusion empirically, pinpoint the source of a given trait, and chart the path of its diffusion through time.

In short, the purpose of archaeoethnology is to establish and explain long-term processes of cultural stability and change.

A. The *Outline of Archaeological Traditions*

The *Outline of Archaeological Traditions* (Peregrine 2001a) was designed to serve as a sampling universe for archaeoethnology. Such a sampling universe must meet several conditions. First, and perhaps most importantly, the cases included must all be equivalent on some set of defining criteria, and those criteria must be sensitive enough to variables of interest that patterns within and among them can be recognized. The *Outline of Archaeological Traditions*, as the name suggests, uses "archaeological traditions" as the units of analysis. These were designed to serve as basic units for archaeoethnology, and are 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*. 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 **not** equivalent to cultures in an ethnological sense because, in addition to socio-cultural defining characteristics, archaeological traditions have **both** a spatial and a temporal dimension. Ethnographic cultures are assumed to exist simultaneously in an "ethnographic present," and hence lack a temporal dimension. Archaeological traditions have a temporal dimension. Archaeological traditions are also defined by a somewhat different set of socio-cultural characteristics than ethnological cultures. Archaeological traditions are defined in terms of common subsistence practices, socio-political organization, and material industries, but language, ideology, kinship ties, and political unity play little or no part in their definition, since they are virtually unrecoverable from archaeological contexts. In contrast, language, ideology, and cross-cutting ties are central to defining ethnographic cultures.

The concept of archaeological tradition as it is used in the *Outline of Archaeological Traditions* was influenced by, but is also **not** equivalent to, the concept of archaeological tradition as used by Gordon Willey and Philip Phillips (1958:37), which they define as "a (primarily) temporal continuity represented by persistent configurations in single technologies or other systems of related forms." The emphasis for Willey and Phillips is on the temporal dimension, (Willey and Phillips [1958:33] use the concept of "horizon" to express the spatial dimension of archaeological traditions) and the focus is on technology (most frequently pottery) rather than broader socio-cultural characteristics. Once again, archaeological tradition as it is used in the *Outline of Archaeological Traditions* has both a spatial and temporal dimension, and is defined primarily by socio-cultural characteristics.

A valid sampling universe must also include all possible cases, and the *Outline of Archaeological Traditions* is a catalogue of all known archaeological traditions, covering the entire globe and the entire prehistory of humankind. The *Outline of Archaeological Traditions* begins its coverage with the origins of our genus, *Homo*, approximately two million years ago in Africa. *Homo* spread throughout Eurasia by 500,000 years ago, into Oceania by 40,000 years ago, and into the Americas by 12,000 years ago. Area coverage for those regions begins when humans first enter them. The ending date of the *Outline's* coverage also varies by region. In Oceania, the Americas, and Sub-Saharan Africa, coverage ends at approximately 500 BP with European exploration and initial colonization. In Central Asia coverage ends with the rise and spread of nomadic states such as the Hsuing-Nu ca. 1500 BP. In Europe coverage ends with the expansion of the Roman Empire ca. 2000 BP. In China coverage ends with the Shang dynasty, ca. 3100 BP. And in Northern Africa and the Middle East, coverage ends with the rise of the New Babylonian and Old Kingdom Egyptian civilizations ca. 3500 BP.

A good sampling universe must also be large enough to allow random samples for hypothesis tests to be drawn from it, taking into account the loss of cases due to missing data, yet small enough to allow basic information for stratified or cluster sampling, or for eliminating cases with specific characteristics. In its current form the *Outline of Archaeological Traditions* contains 289 cases--easily large enough to provide a good universe for sampling. It should be taken as a catalogue in process, which will be continually revised and updated as new information about human prehistory is generated, and as existing information is synthesized and reinterpreted. The *Outline of Archaeological Traditions* is also small enough that basic information for each case has been collected and published in the *Encyclopedia of Prehistory* (Peregrine and Ember, eds. 2001-2002). It is information from the *Encyclopedia of Prehistory* that was used to create the data set presented here.

B. The *Atlas of Cultural Evolution* Data Set

The data set presented and analyzed here is based on a revision of Murdock and Provost's (1973) ten-item Cultural Complexity Scale. The original scale items were each comprised of five-point scales, while Table 1.B.1 shows that for the *Atlas of Cultural Evolution* data set these variables were recoded into three-point scales (also see Peregrine 2001b). The reason for this revision was to make coding easier with archaeological data. The five-point scales required too much inference from the available archaeological record, while the three-point scales made coding decisions considerably easier. The scale items are summed for each case to create its total score for Cultural Complexity.

All coding was done by the author from entries for the *Encyclopedia of Prehistory* as they were received for pre-publication review and editing. Thus cases were coded in a haphazard manner. This procedure should have eliminated any bias from coding cases in a predetermined order (such as oldest to most recent), or systematic inter-coder errors (lack of reliability). It must be noted that these revised scales have not been evaluated for reliability, so that if future coding is done to add cases to the data set, a reliability study should be performed simultaneously. It should also be noted that coding relied exclusively on information provided in the *Encyclopedia of Prehistory* entries. Since these were written by over 200 scholars representing more than 20 foreign nations, it is highly unlikely that any systematic bias due to a particular theoretical perspective or political orientation is present (cf. Shanks and Tilley 1992:245). Basic descriptive statistics for the cases are provided in Part 7.

In addition to the scale items, a number of basic identification and pinpointing variables are also included in the *Atlas of Cultural Evolution* data set. These include the tradition name; start, end, and midpoint dates; locational information; and time-series variables. These are presented in the Codebook in Part 6. Maps are also provided in Part 5 to show the location of each archaeological tradition, along with digital files and the *MapMaker Gratis* software package, allowing scholars to employ a Geographic Information System in the examination of these data.

Table 1.B.1--Scales Comprising the Murdock & Provost (1973) Index of Cultural Complexity, Recoded for Use with Archaeological Cases

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

C. The *Atlas of Cultural Evolution* and the *Standard Cross-Cultural Sample*

It must be emphasized that because the units of analysis are different, it would not be valid to select cases for comparison from both the *Atlas of Cultural Evolution* (ACE) and a list of ethnographic cases, such as the *Standard Cross-Cultural Sample* (SCCS)(Murdock and White 1969). To illustrate this point, Table 1.C.1 presents a comparison of descriptive statistics for the ACE and the SCCS coded on the same ten-item Cultural Complexity Scale (Murdock and Provost 1973) as revised for archaeological use, while Table 1.C.2 presents the results of Mann-Whitney U tests. Clearly differences are present.

Table 1.C.1 illustrates that means tend to be higher in the SCCS than the ACE, and Table 1.C.2 demonstrates that rank scores on all but one item of the Cultural Complexity Scale are significantly higher in the SCCS. This makes sense because the ACE contains cases from early in human prehistory, when all cases were non-complex; that is, they were low on all measures of the Cultural Complexity Scale. Because of this, the ACE should be expected to have scores on each scale item that are significantly lower than the SCCS. It is interesting that the one scale item where scores were not significantly different was Social Stratification. This may imply that the SCCS tends to under-represent socially stratified societies in the contemporary world--a critique that has, indeed, been levied against the sample (e.g. Otterbein 1976).

Table 1.C.1--Descriptive Statistics for ACE and SCCS

Variable	ACE N	Mean	Std. Deviation	SCCS N	Mean	Std. Deviation
Writing and Records	289	1.15	0.525	186	1.84	0.775
Fixity of Residence	289	2.30	0.856	186	2.48	0.744
Agriculture	289	2.09	0.955	186	2.44	0.812
Urbanization	289	1.71	0.815	186	1.99	0.771
Technological Specialization	289	1.94	0.770	186	2.27	0.787
Land Transport	289	1.35	0.623	186	1.54	0.698
Money	289	1.21	0.555	186	2.10	0.959
Density of Population	289	1.62	0.667	186	2.09	0.843
Political Integration	289	1.80	0.748	186	2.10	0.455
Social Stratification	289	1.77	0.814	186	1.81	0.691
Cultural Complexity	289	16.95	5.979	186	20.65	5.042

Table 1.C.2 -- Mann-Whitney U Statistics for ACE and SCCS

Variable	Sample	N	Mean Rank	Mann-Whitney U	p
Writing and Records	ACE SCCS	289 186	191.30 310.57	13379.50	0.000
Fixity of Residence	ACE SCCS	289 186	229.10 251.82	24306.00	0.046
Agriculture	ACE SCCS	289 186	220.80 264.73	21905.00	0.000
Urbanization	ACE SCCS	289 186	219.82 266.25	21622.00	0.000
Technological Specialization	ACE SCCS	289 186	216.64 271.19	20704.00	0.000
Land Transport	ACE SCCS	289 186	224.24 259.39	22899.00	0.001
Money	ACE SCCS	289 186	193.88 306.55	14127.500	0.000
Density of Population	ACE SCCS	289 186	209.26 282.66	18570.00	0.000
Political Integration	ACE SCCS	289 186	214.75 274.13	20157.50	0.000
Social Stratification	ACE SCCS	289 186	233.45 245.07	25561.50	0.333
Cultural Complexity	ACE SCCS	289 186	204.04 290.76	17064.00	0.000

If we compare the SCCS with the most recent cases in the ACE, those that were in existence during the last 1000 years, we still find statistically significant differences, as demonstrated in Table 1.C.3. While there are fewer significant differences (5 of 10 as opposed to 9 of 10 using all ACE cases), it is still clear that the two data sets are quite different.

Table 1.C.3 -- Mann-Whitney U Statistics for ACE cases 1000 years ago and SCCS

Variable	Sample	N	Mean Rank	Mann-Whitney U	p
Writing and Records	ACE SCCS	77 186	79.75 153.63	3138.00	0.000
Fixity of Residence	ACE SCCS	77 186	143.16 127.38	6301.500	0.068
Agriculture	ACE SCCS	77 186	128.66 133.38	6904.00	0.590
Urbanization	ACE SCCS	77 186	131.04 132.40	7087.00	0.888
Technological Specialization	ACE SCCS	77 186	120.73 136.67	6293.00	0.094
Land Transport	ACE SCCS	77 186	100.45 145.06	4732.00	0.000
Money	ACE SCCS	77 186	88.25 150.11	3792.50	0.000
Density of Population	ACE SCCS	77 186	113.79 139.54	5759.00	0.008
Political Integration	ACE SCCS	77 186	126.01 134.48	6699.50	0.295
Social Stratification	ACE SCCS	77 186	141.01 128.27	6467.50	0.183
Cultural Complexity	ACE SCCS	77 186	109.52 141.31	5430.00	0.002

This comparison is not intended to promote the use of one sample over the other; indeed, quite the opposite. Each sample allows the researcher to generalize to a particular population. The SCCS is designed to represent the range of variation in the cultures of recent times, while the ACE is designed to represent the range of variation in the cultures of the past. And things have changed. The cultures of the past were overall less complex, at least as measured by these variables, than the cultures of recent times. These differences are present because cultural evolution has taken place.

D. Conclusion

The ACE provides the first set of coded data for the OAT sample. The OAT itself is the first statistically-valid sample of archaeological cases for comparative analysis. The OAT can be thought of as roughly equivalent to the SCCS for comparative research, but the two should not be used together, as the cases used in each are defined in very different ways. The importance of the ACE data set is that it provides us with the opportunity to undertake exercises in archaeoethnology; that is, comparative research on culture, behavior, and evolution with both geographic and temporal dimensions.

2. CULTURAL EVOLUTION

Cultural evolution is conventionally defined as change in societal scale, complexity, and integration (Blanton et al. 1981:17). Scale refers to the physical size of a society, measured through population, geographical extent, or, more typically in archaeological and cross-cultural research, through the size of the largest city (see McNett 1970). Complexity refers to the number of different roles available in the society. Integration refers to the number of interconnections between social roles. All three aspects of cultural evolution are captured in Murdock and Provost's (1973) Cultural Complexity Scale.

Societal scale is measured through Murdock and Provost's scale items four (urbanization) and seven (density of population). Gary Chick (1997) has also argued that societal scale is one of two underlying factors that comprise the Cultural Complexity Scale, a factor built from scale items four and seven, along with items two (fixity of residence) and three (agriculture). Here I refer to this as the Scale Factor.

Societal complexity is measured through Murdock and Provost's scale items five (technological specialization) and ten (social stratification). It could be argued that complexity is also related to items one (writing and records), six (land transport), seven (money), and nine (political integration), as these typically require specialists. Gary Chick (1997) has suggested these items form a second underlying factor within the Cultural Complexity scale, which I refer to as the Technology Factor.

Finally, societal integration is measured through Murdock and Provost's scale item nine (political integration), and perhaps through items one (writing and records) and seven (money). Unfortunately, there is little variation in the ACE on the latter two variables, and thus they are of little use in the examination of societal integration.

A. Describing Evolutionary Trends

The key question here is whether clear evolutionary trends can be identified through the ACE data. Table 2.A.1 suggests that evolutionary trends are present. Societal scale, complexity, and integration are all significantly correlated with two different measures of time. The first measure, Date, is the midpoint of time range within which a given case existed. The second measure, Time Series End, is the endpoint of that time range, adjusted to the nearest millennium. Only the last 12,000 years are included in the Time Series End correlations. The two variables show correlations in opposite directions because Date is measured in years before the present, and thus gets larger the farther back one goes into the past, while Time Series End is a time series count that starts 12,000 years ago and gets larger as one moves closer to the present.

Table 2.A.1 -- Spearman's rho Correlation Coefficients Showing the Relationship between Date and Cultural Complexity

Variable	Date	p	Time Series End	p
Writing and Records	-0.065	0.274	-0.060	0.319
Fixity of Residence	-0.557	0.000	0.345	0.000
Agriculture	-0.484	0.000	0.250	0.000
Urbanization	-0.512	0.000	0.313	0.000
Technological Specialization	-0.576	0.000	0.367	0.000
Land Transport	-0.068	0.249	-0.132	0.029
Money	-0.185	0.002	0.108	0.074
Density of Population	-0.420	0.000	0.217	0.000
Political Integration	-0.555	0.000	0.317	0.000
Social Stratification	-0.503	0.000	0.275	0.000
Cultural Complexity	-0.572	0.000	0.324	0.000
Technology Factor	-0.557	0.000	0.315	0.000
Scale Factor	-0.554	0.000	0.317	0.000

Looking more closely at Table 2.A.1 we also see that three of the ten Cultural Complexity Scale variables do not appear to be strongly correlated with either measure of time--Writing and Records, Land Transport, and Money. All three are problematic when applied to the ACE cases, as all measure fairly recent, and relatively rare (until the last century or so) technological developments. Thus, there is very little variation in any of these variables until the recent past, which can be readily seen in Figure 2.A.1, 2.A.2, and 2.A.3. These figures present the means for each variable at 1000-year intervals over the past 12,000 years, and it is clear that most of the cases for all three were coded 1, even in the recent past.

Figure 2.A.1 -- Mean of Writing and Records by Date

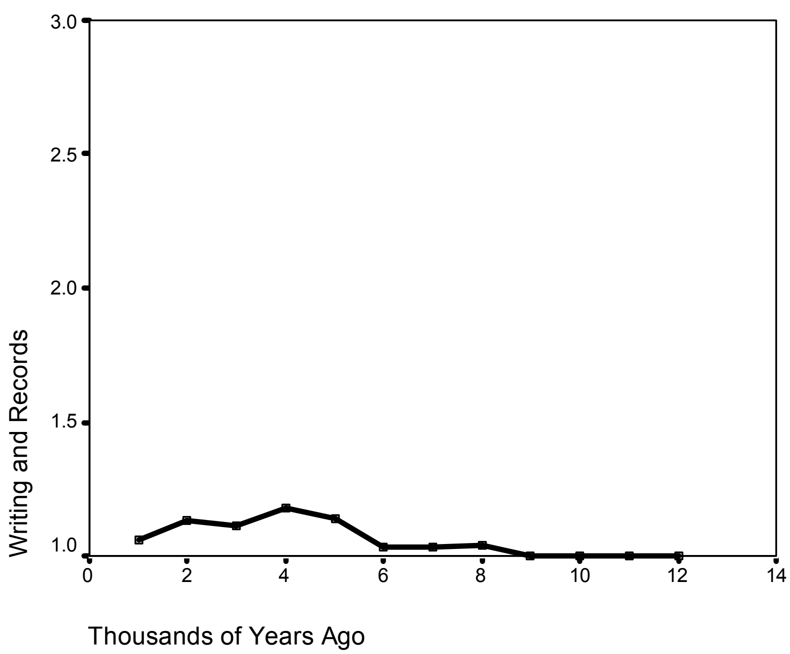


Figure 2.A.2 -- Mean of Transportation by Date

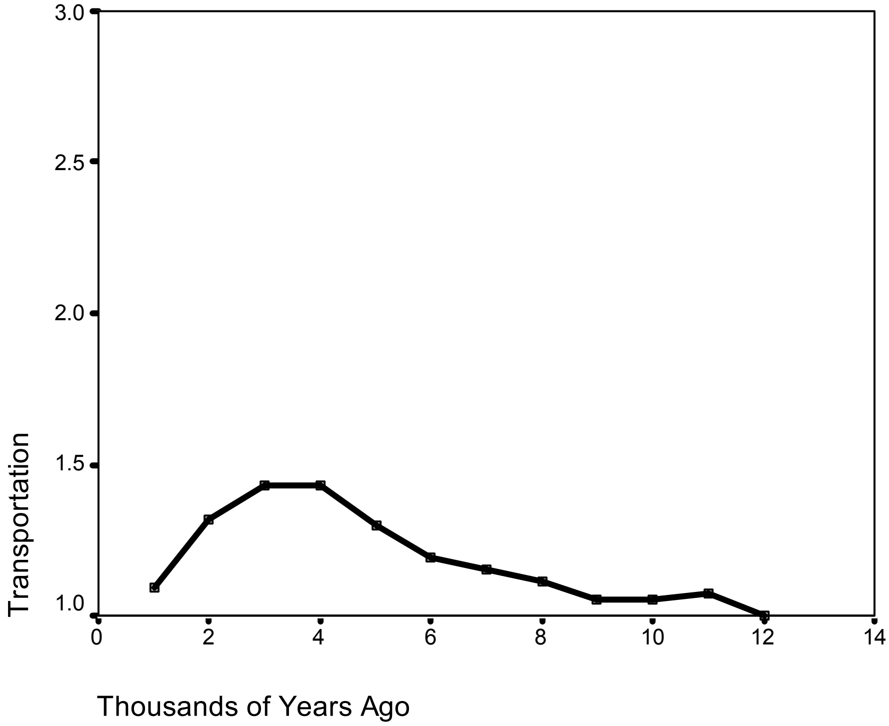
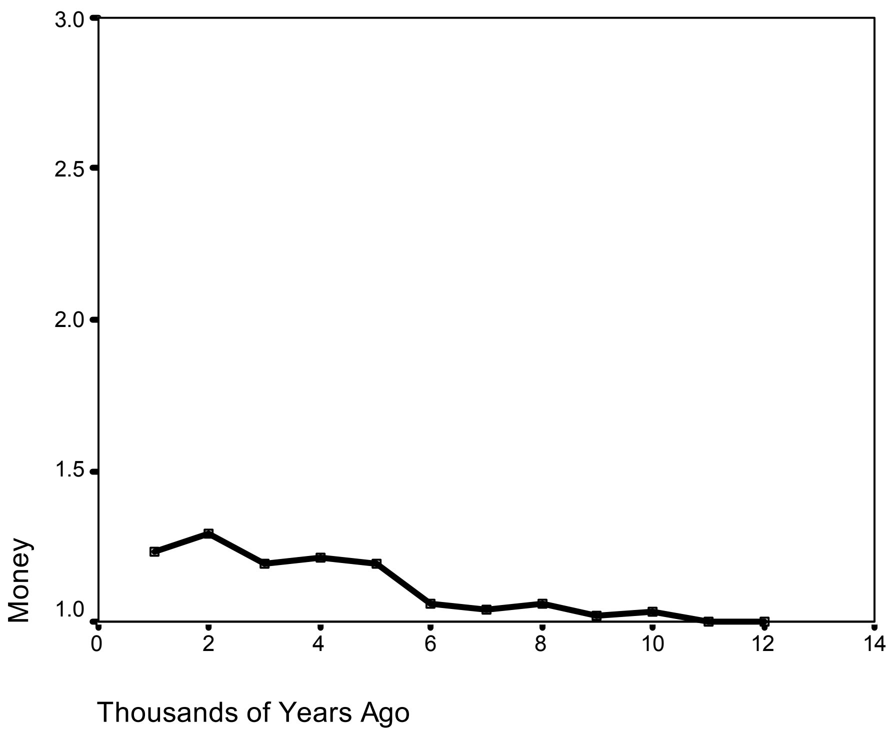


Figure 2.A.3 -- Mean of Money by Date



One other problem with the ACE data is that once a case achieves writing, it quickly moves into history and, by definition, out of the archaeological record which the ACE is intended to capture. Hence, it is not surprising that writing shows an arched curve, for when cases develop writing they quickly move out of the sample so that over time all that are left are those cases lacking writing. This trend is perhaps more clearly illustrated with Land Transport, and is also evident for Money. It should not be surprising that these three variables are highly inter-correlated, and appear to be directly related to those cases on the cusp of the historical record. Because of these problems, I will not examine these variables in detail.

Societal Scale

Changes in societal scale are perhaps best measured by the Urbanization and Population Density variables. Graphs showing the means of these variables at 1000-year intervals for the last 12,000 years are given in Figures 2.A.4 and 2.A.5. Means have clearly increased over time, and in a roughly linear fashion; indeed, R-squared values for these two figures are 0.904 and 0.978, respectively. With these results one could argue that societal scale has increased in a roughly linear fashion over the past 12,000 years. That is, cultural evolution in terms of societal scale has taken a single, unilineal form (but see section 2.B below).

Figure 2.A.4 -- Mean of Urbanization by Date

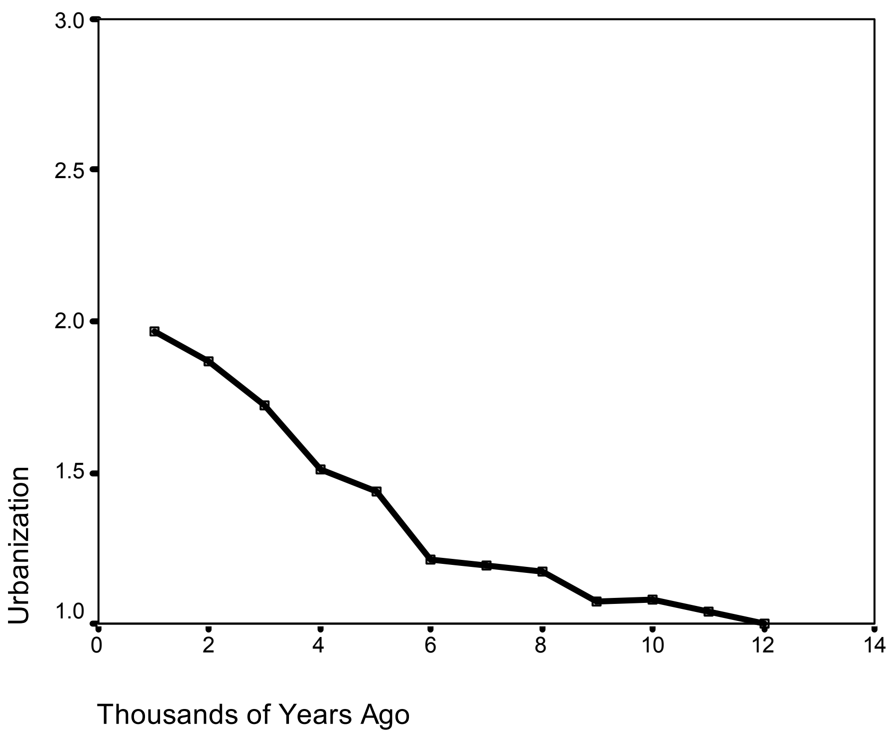


Figure 2.A.5 -- Mean of Population Density by Date

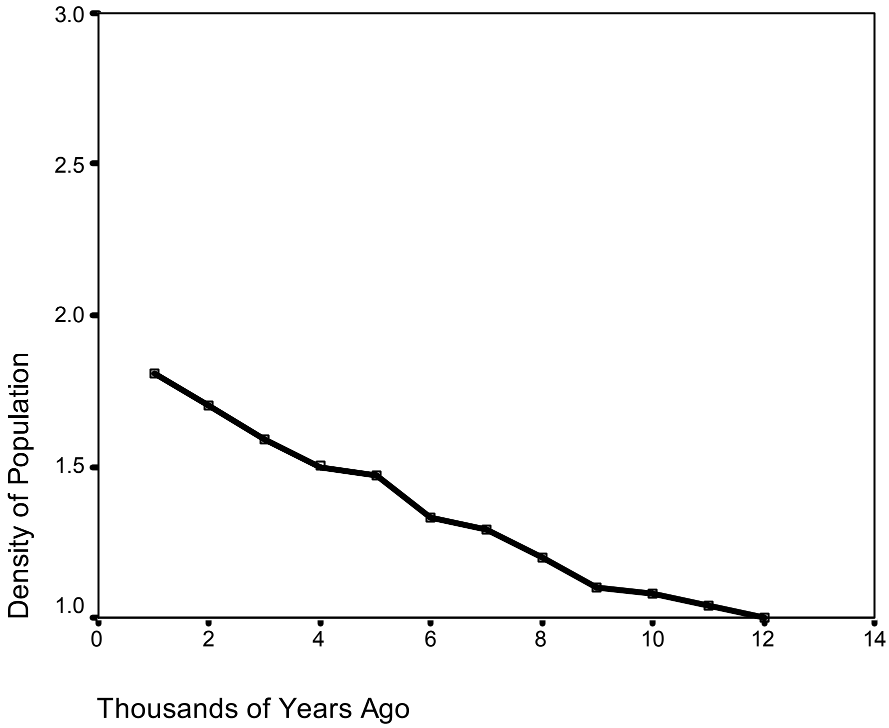


Figure 2.A.6 -- Mean of Scale Factor by Date

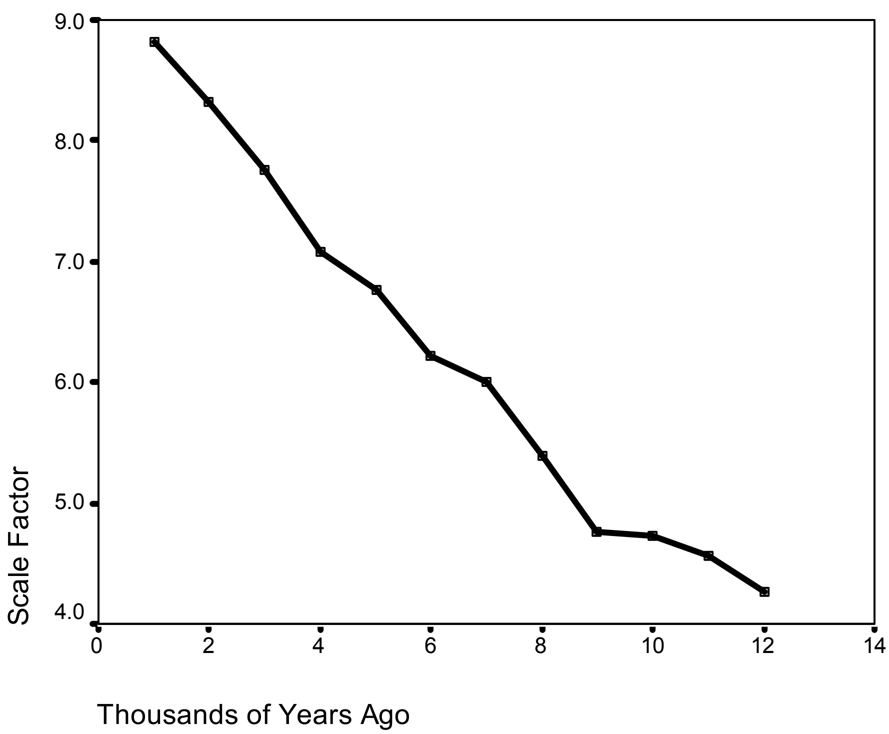


Figure 2.A.6 displays means of the Scale Factor plotted at 1000-year intervals. The Scale Factor, as explained above, is the sum of the Density of Population, Urbanization, Fixity of Residence, and Agriculture variables. Not surprisingly, the Scale Factor also shows a linear trend over time, with an R-squared value of 0.976. Again, it appears that societal scale has increased in a roughly linear fashion over the past 12,000 years.

Societal Complexity

Societal complexity also appears to have increased in a roughly linear fashion over the past 12,000 years, as illustrated in Figures 2.A.7, 2.A.8, and 2.A.9. Figure 2.A.7 shows the mean values of Technological Specialization plotted at 1000-year intervals, while Figure 2.A.8 shows Social Stratification. Both illustrate linear trends with R-squared values of 0.960 and 0.935, respectively. Figure 2.A.9 shows the mean values for the Technology Factor (which sums the Technological Specialization, Social Stratification, Writing and Records, Land Transport, Money, and Political Integration variables) plotted at 1000-year intervals. It, too, illustrates a linear trend with an R-squared value of 0.949. It should be noted that the "dip" at 1000 years ago evident in each plot is probably due to the more complex cases being dropped from the sample once they gain writing and become historic (this should be particularly true in Figure 2.A.9, where the Writing variable is included in the Technology Factor).

Figure 2.A.7 -- Mean of Technological Specialization by Date

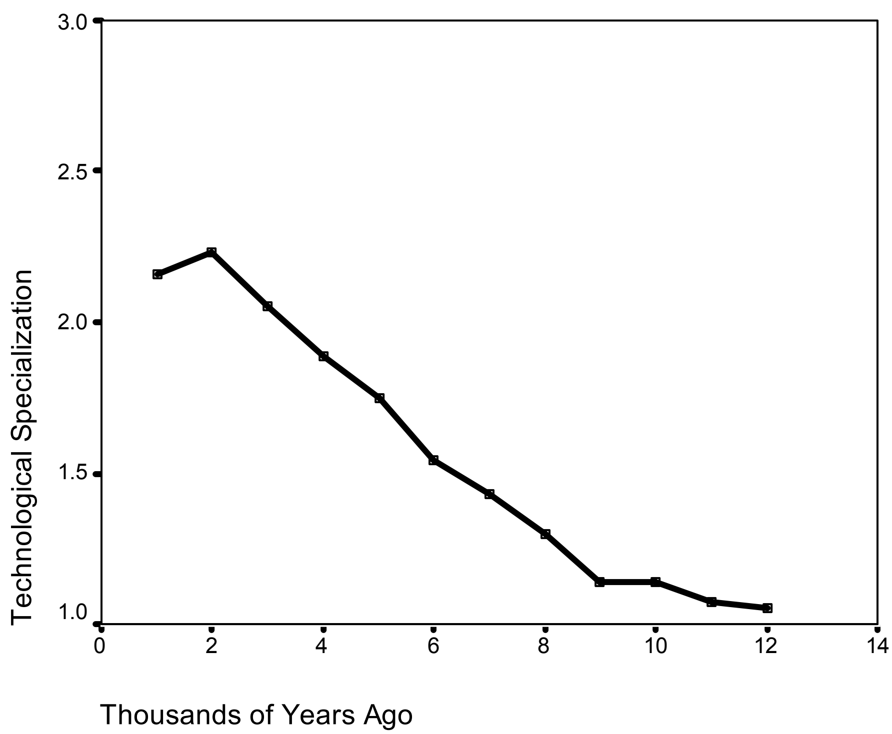


Figure 2.A.8 -- Mean of Social Stratification by Date

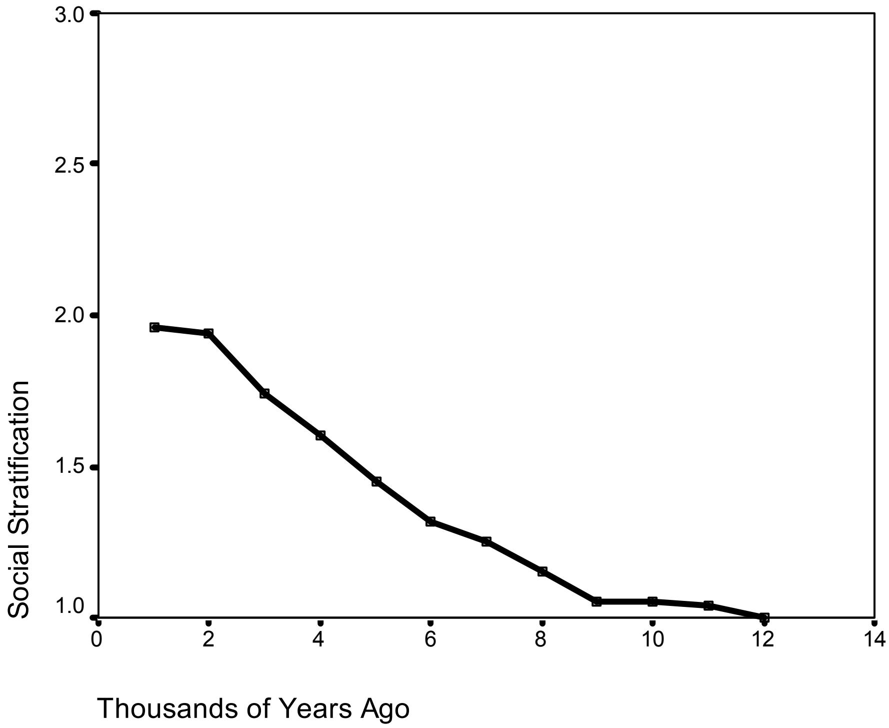
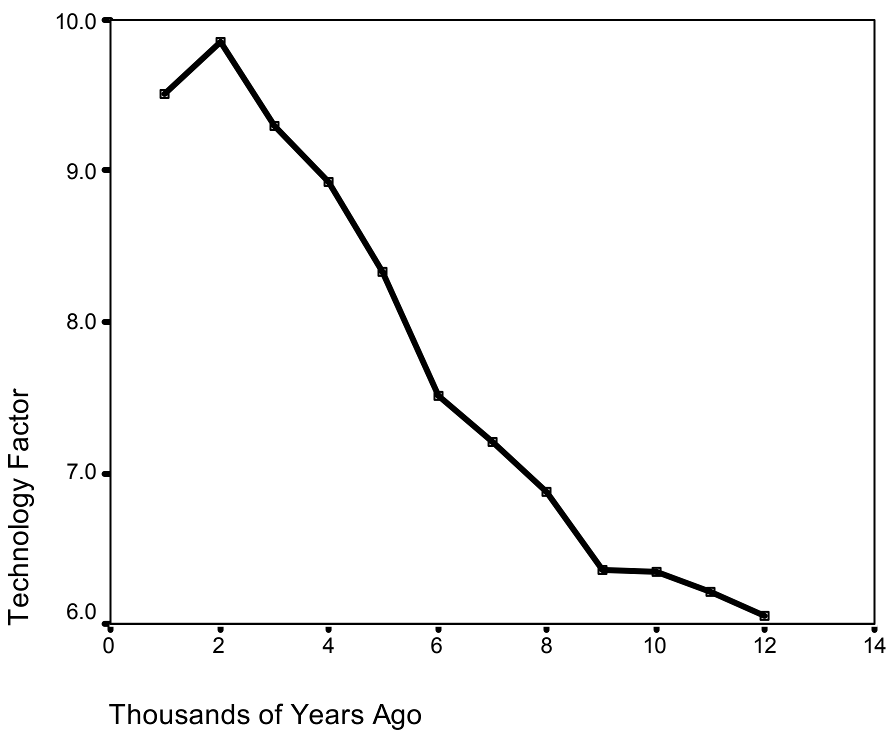


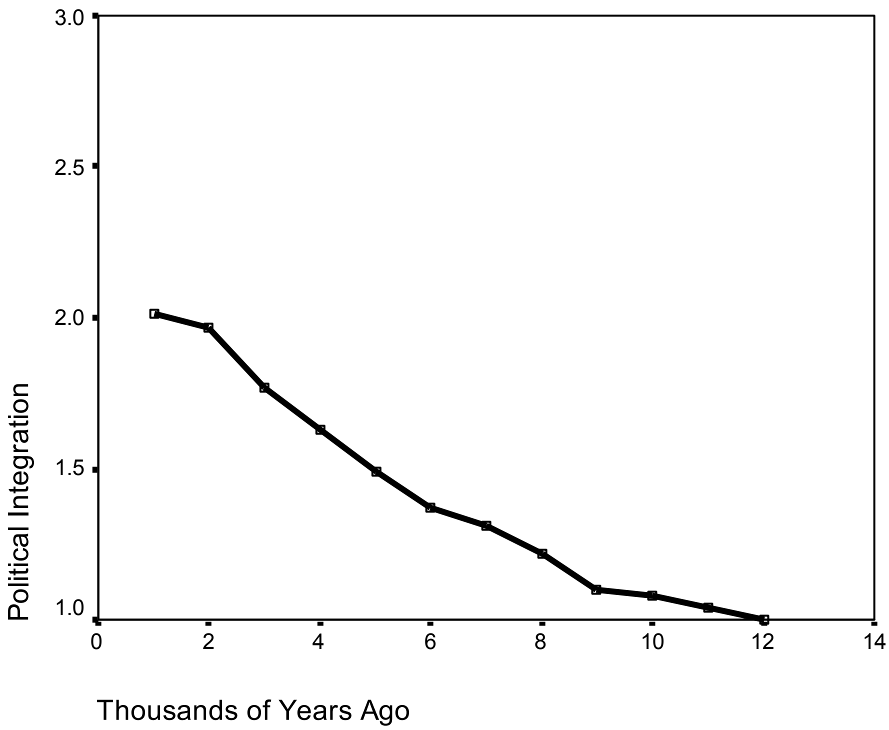
Figure 2.A.9 -- Mean of Technology Factor by Date



Societal Integration

Finally, a linear trend is also evident in societal integration. Figure 2.A.10 shows the mean value of Political Integration plotted at 1000-year intervals for the past 12,000 years. Here the trend has an R-squared value of 0.956.

Figure 2.A.10 -- Mean of Political Integration by Date



It seems clear that societal scale, complexity, and integration have all increased in a roughly linear fashion over the past 12,000 years. Thus, there is clear evidence for unilineal trends in cultural evolution such that societal scale, complexity, and integration all tend to increase over time. The presence of these unilineal evolutionary trends clearly supports the validity of cultural evolutionary research, and contradicts critiques made by scholars such as Goldenwiser (1937), Lowie (1946), Nisbet (1969), and Giddens (1984) that research into unilineal evolution is invalid because such unilineal trends cannot be demonstrated to exist. These data illustrate that unilineal evolutionary trends do exist, and their existence begs the question of why they exist.

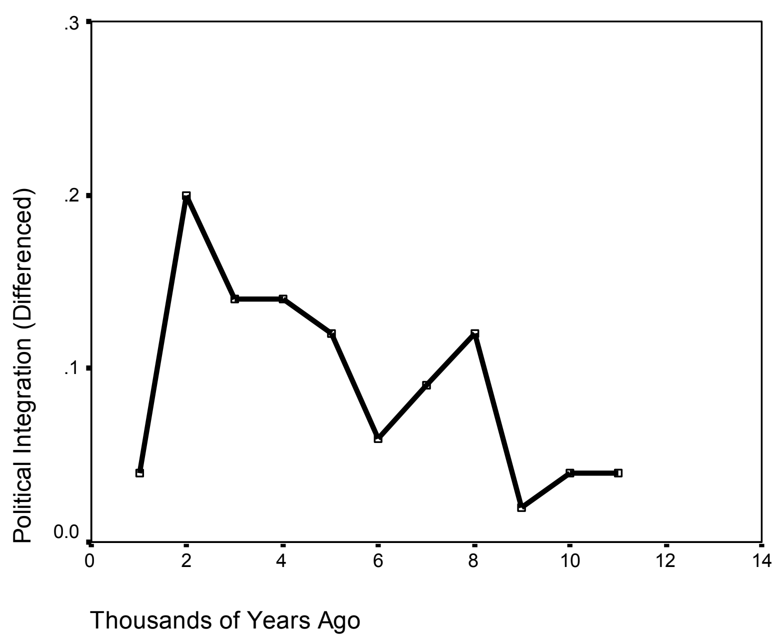
Before turning to the question of why unilineal evolutionary trends exist, or rather, how one might approach an answer to that question, I need to address two other issues: the problem of autocorrelation and the interesting fact of Old World-New World differences in cultural evolution.

B. Autocorrelation

There is an interesting statistical problem in exploring cultural evolution with the ACE data set, that of autocorrelation. Autocorrelation refers to a situation where two cases are not statistically independent because changes in one case cause changes in the other. Cultural evolution itself can be thought of as something of a serial autocorrelation process. Change in an ancestral society leads to those changes being transmitted to descendants; thus, values of a variable measuring that change will be serially autocorrelated when viewed over time. For example, if members of an archaeological tradition develop metalwork, it is likely that metalworking will be passed on to descendents. The ACE variable TECHNOLO will thus present serial autocorrelation between the ancestral archaeological tradition and its descendents, as the development of metalwork is causally linked to the descendent populations having metalwork.

Autocorrelation is generally regarded as a problem in statistical analyses because it tends to artificially inflate correlation and regression coefficients (Ostrom 1990:21-26). Thus, because of autocorrelation, the R-squared value of 0.956 I reported for Figure 2.A.10 is likely inflated. One way to estimate whether such a value is likely inflated from autocorrelation is through the Durban-Watson statistic, which examines residuals to determine whether or not they are randomly distributed (randomly distributed residuals would suggest no autocorrelation). The Durban-Watson statistic for Figure 2.A.10 is 0.53, which, not surprisingly, suggests autocorrelation is present (a standard table is used to determine the significance level of the Durban-Watson statistic given the number of time periods and variables being used).

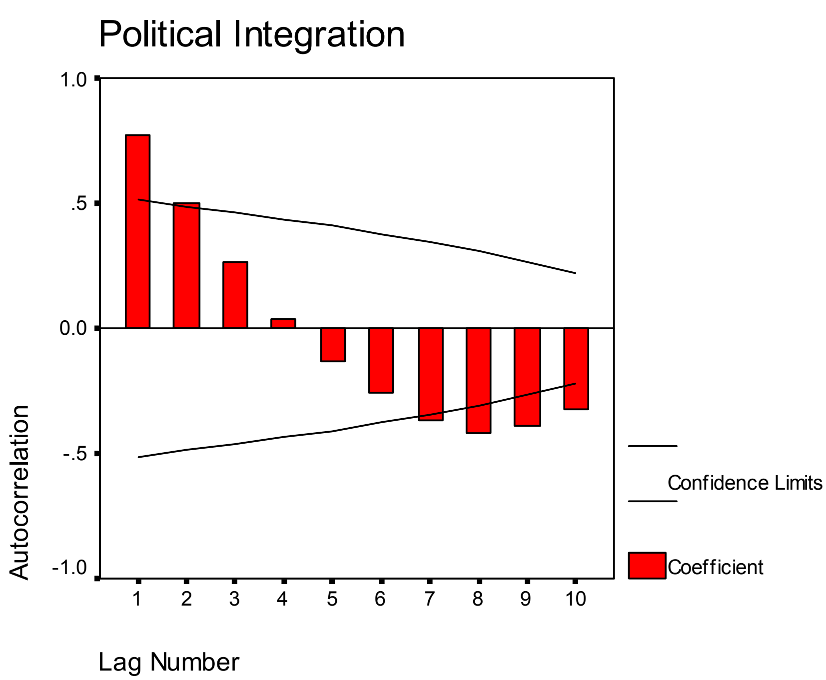
Figure 2.B.1 Mean of Political Integration by Date, Differenced to Remove Autocorrelation.



The question is, what is the effect of autocorrelation on our understanding or interpretation of these data? How might autocorrelational effects be interpreted or corrected? One way of dealing with autocorrelation is to filter out its effects though various algorithms that take previous values for a given variable and remove or "difference" them from future values. Figure 2.B.1 shows a plot of political integration with autocorrelation removed by differencing each time period from the previous time period. The value of R-squared for these data is 0.324, considerably lower than that for the non-differenced data. However, 1000 B.P. seems to be a rather marked outlier here, and I would argue this is because the general problem associated with cases in this time period noted earlier (that many of the more complex cases have entered the historic record and been dropped from the data set) has been amplified through differencing. Dropping this outlier leads to an R-squared value of 0.762, which I suggest is a better estimate of the actual value for this figure and perhaps for Figure 2.A.10.

A second way of dealing with serial autocorrelation is to focus on individual time periods in relation to their immediately preceding and following time periods, rather than on the overall trend. This is the primary approach used in time-series analysis, a set of analytical methods that is far too large and sophisticated to be dealt with in any detail here (see, e.g., Gottman 1981; McCleary and Hay 1980). Figure 2.B.2 shows a typical time-series graph for the political integration variable. What it illustrates is essentially what I noted above: there is significant autocorrelation between each time period and the preceding time period. What is interesting is that the autocorrelation declines rather sharply, suggesting a fairly strong and regular process is at work, a process which we might identify simply as cultural evolution.

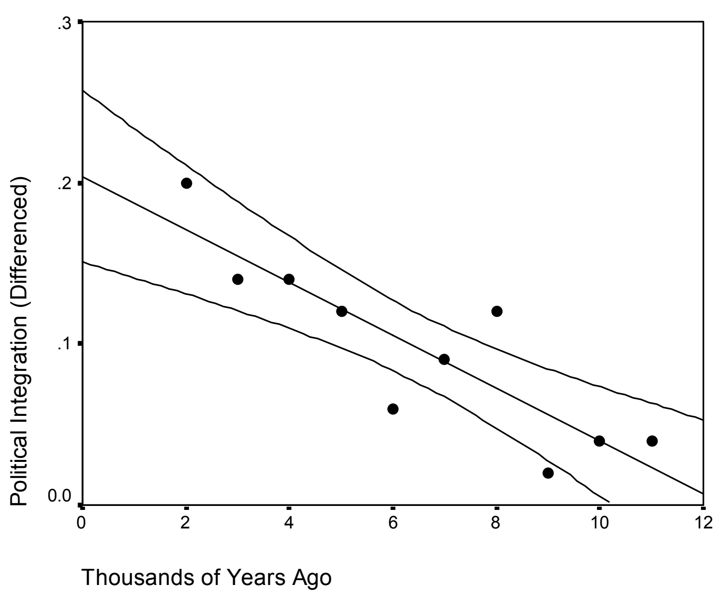
Figure 2.B.2 Autocorrelation Graph for Political Integration



The fact that cultural evolution is a serial autocorrelation process makes me question whether, indeed, it is a problem we need to address in studying cultural evolution rather than an expectation that we only concern ourselves with in its absence or when it is violated. Take, for example, an ordinary bank account. We put $100 in an each month interest accrues. If we chart the amount of money in the account each month, we discover serial autocorrelation--the amount in the account each month is correlated with the previous and future months' amounts with the specific value equivalent to the interest rate. The increase, due to interest, is expected, and perhaps uninformative, but it is real and should not be considered a problem. What might be more interesting, however, is the extent to which the interest rate changes. The monthly balance will always show strong autocorrelation with the previous month. But if we factor out that autocorrelation through differencing and look only at the changes in the rates of increase, that might yield interesting insights into the process of how interest works.

The exact same thing can be said for cultural evolution. It appears to be a regular process of serial autocorrelation. If we factor out autocorrelation and look only at the changes that remain, the exercise might yield interesting results. Figure 2.B.1 shows such results, and illustrates that, while the evolution of political integration has been an overall linear process, there have been marked peaks and valleys, as illustrated in Figure 2.B.3. There is a high outlier at 8,000 years ago, and a low outlier at 6,000 years ago. This may suggest that political integration took off rapidly around 8,000 years ago and then, over the course of 2,000 years, slowed markedly before resuming a generally linear upward trend. Is this important? Does it tell us new things about cultural evolution? Perhaps, and I suggest that because we may gain insights from such questions viewing autocorrelation as part of the evolutionary process rather than as a statistical problem is by far the best approach.

Figure 2.B.3 Political Integration by Date, Showing Regression Line and Confidence Intervals



C. New World-Old World Differences in Cultural Evolution

I offered political scientist Claudio Cioffi access to the OAT cases for his Long-Range Analysis of War (LORANOW) project early in 1997, and he undertook several analyses using the sample (Cioffi, personal communication). He suggested that cultural evolution appeared to occur more rapidly in the New World than in the Old. I found this interesting, since other cross-cultural studies had indicated that North America often produced divergent results when compared to other world areas (e.g. Ember 1975). In examining the ACE data, it appears that there are marked differences in cultural evolution between the Old World and the New World.

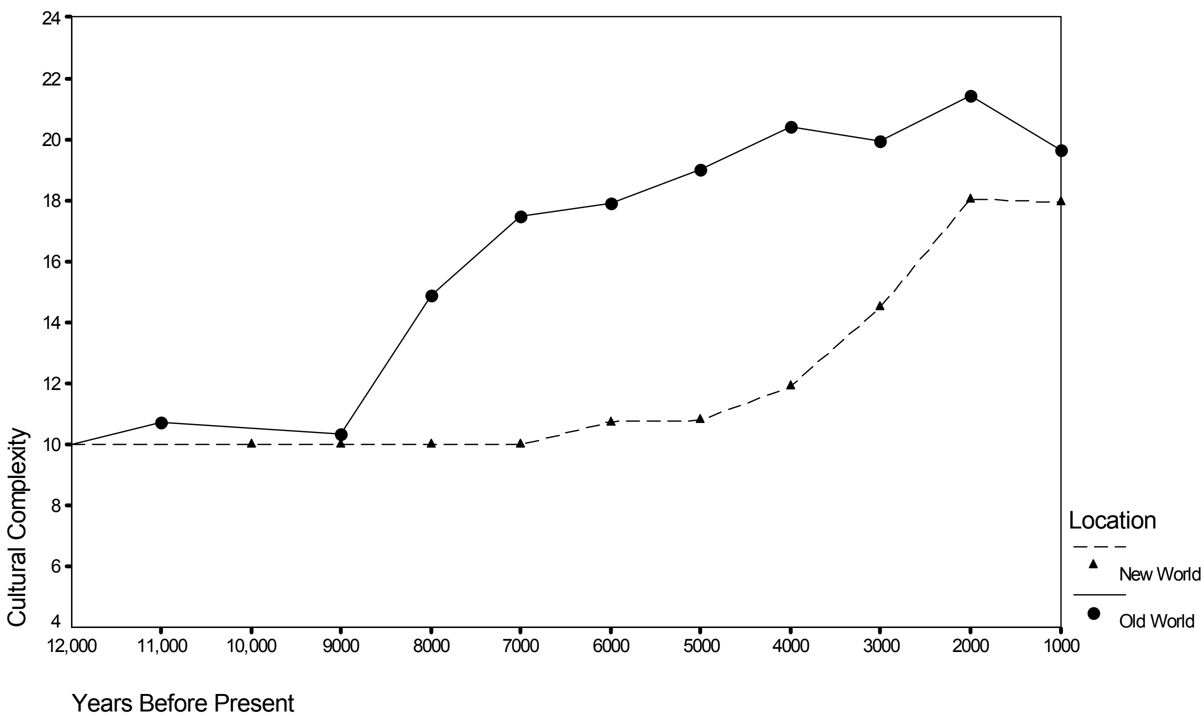
Table 2.C.1 illustrates that New World cases appear to score significantly lower on a number of variables, particularly Writing and Records, Technological Specialization, Land Transport, Money, Density of Population, Social Stratification, and overall Cultural Complexity. These differences are not surprising, as only a handful of New World traditions developed writing or metalwork, and none developed currency or vehicular land transport. More interesting is the fact that New World traditions have less dense and less stratified populations. One might question whether these variables are causally linked in some way, a question I will return to in the next section.

Table 2.C.1 Mann-Whitney U Statistics for New World and Old World Cases

Variable	Location	N	Mean Rank	Mann-Whitney U	p
Writing and Records	New World Old World	128 161	137.96 150.60	9402.5	0.0064
Fixity of Residence	New World Old World	128 161	140.77 148.37	9762.0	0.3898
Agriculture	New World Old World	128 161	135.84 152.29	9131.0	0.0632
Urbanization	New World Old World	128 161	146.61 143.72	10098.0	0.7493
Technological Specialization	New World Old World	128 161	132.51 154.93	8705.0	0.0157
Land Transport	New World Old World	128 161	120.55 164.44	7174.0	0.0000
Money	New World Old World	128 161	130.47 156.55	8444.0	0.0000
Density of Population	New World Old World	128 161	129.18 157.58	8279.0	0.0015
Political Integration	New World Old World	128 161	140.88 148.28	9776.0	0.4206
Social Stratification	New World Old World	128 161	134.43 153.40	8951.0	0.0385
Cultural Complexity	New World Old World	128 161	133.41 154.21	8821.0	0.0343

Figure 2.C.1 illustrates the fact that, while the evolution of overall cultural complexity occurred later in the New World than the Old World, and never attained the same level, the evolutionary process towards greater complexity apparently operated at roughly the same speed in both areas. The evolution of more complex cultures began about 9000 years ago in the Old World, and took roughly 5000 years to plateau. In the New World, the evolutionary process began only about 5000 years ago, and was still increasing when the conquest and subsequent collapse of New World cultures began. So, while beginning more recently than the Old World, it appears that the evolution of cultural complexity moved at about the same pace in both the New World and the Old.

Figure 2.C.1 Mean Cultural Complexity by Date for Old World and New World Cases



D. Conclusion

The ACE data illustrate clear, unilineal trends in cultural evolution. These trends show complex and sometimes divergent patterns that suggest the empirical study of cultural evolution with data like those provided here is rich with potential. Not only are the patterns themselves potentially of great interest, but methods to elucidate and, perhaps, explain them also seem a rich area for further research.

3. TOWARD EXPLAINING CULTURAL EVOLUTION

The work of anti-evolutionists such as Lowie, Nisbet, and Giddens has been effective, and largely halted work on identifying and explaining evolutionary trends during much of the 20th century. While scholars such as White (1959), Fried (1967), Service (1975), Harris

(1979), and Boyd and Richerson (1985) developed theoretical frameworks for understanding unilineal evolution, there were few systematic attempts (beyond those of these scholars themselves) to evaluate or refine these theories. The ACE provides a first step towards doing so, as I hope to demonstrate here.

A. Causal Variables and Prime Movers

Three variables included within the ACE data set seem to be repeatedly identified as underlying cultural change. These are population density, reliance on agriculture, and technological specialization. Not surprisingly, all three are strongly inter-correlated, and all three correlate strongly with both cultural complexity and time in years B.P., as shown in Table 3.A.1. Each has been proposed as something as a "prime mover" underlying cultural evolution. Population density, for example, has been proposed as the cause of agriculture around the world (Cohen 1977), and agriculture as the cause of technological innovation (Harris 1977). These correlations alone suggest such causal relationships may exist, but, as has been said so often, correlation is not equivalent to causation.

Table 3.A.1 -- Spearman's rho Correlation Coefficients for Selected Variables

Population Density	1.0				
Importance of Agriculture	0.817	1.0			
Technological Specialization	0.689	0.717	1.0		
Cultural Complexity	0.876	0.873	0.892	1.0	
Date B.P.	-0.420	-0.484	-0.576	-0.572	1.0
	Population Density	Importance of Agriculture	Technological Specialization	Cultural Complexity	Date B.P.

The task, then, is to examine how these variables inter-relate, and to determine whether change in the value of one causes change in the values of the others. Since these data are diachronic, they should allow us to see whether change in a presumed causal variable actually proceeded its presumed effects. In other words, one can also examine them as a time series to see whether changes in one or more of these variables precedes changes in the others. This ability to examine causal relationships diachronically is one of the unique strengths of archaeoethnology for identifying and exploring cultural evolution.

Figure 3.A.1 shows a time series plot of population density, agriculture, and technological specialization. Unfortunately, there does not seem to be a single causal or "prime mover" variable among the three--each increases at a fairly steady rate, and all tend to increase together. Using differencing to "de-trend" the plot yields Figure 3.A.2. Again, there seems no clear "prime mover" here; indeed, the three variables seem remarkably inter-correlated, although agriculture does seem to lag behind population density and technological specialization after about 6000 years ago.

Figure 3.A.1 Time Series Plot of Population Density, Agriculture, and Technological Specialization.

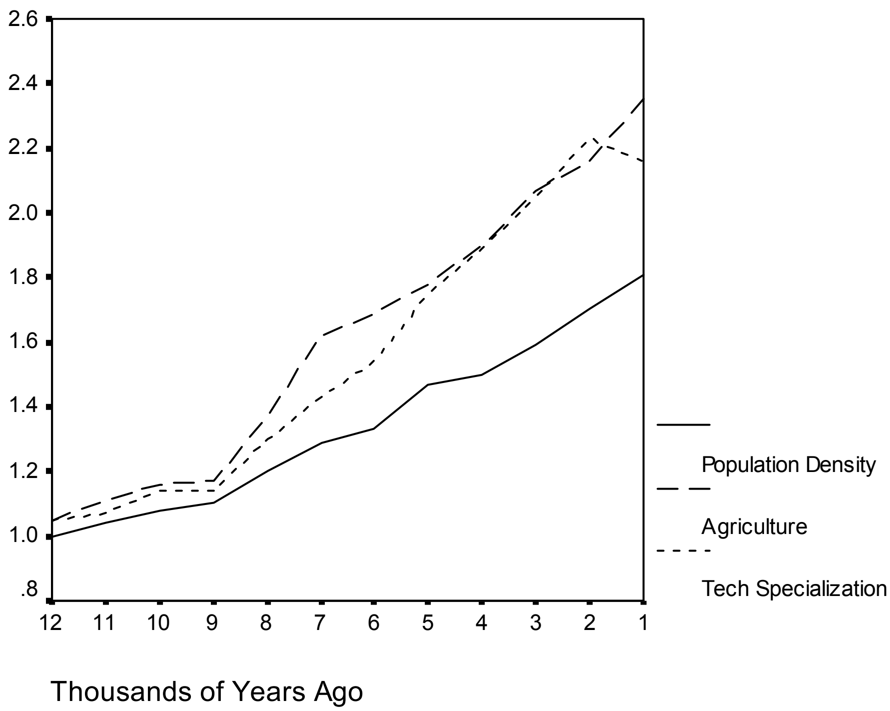
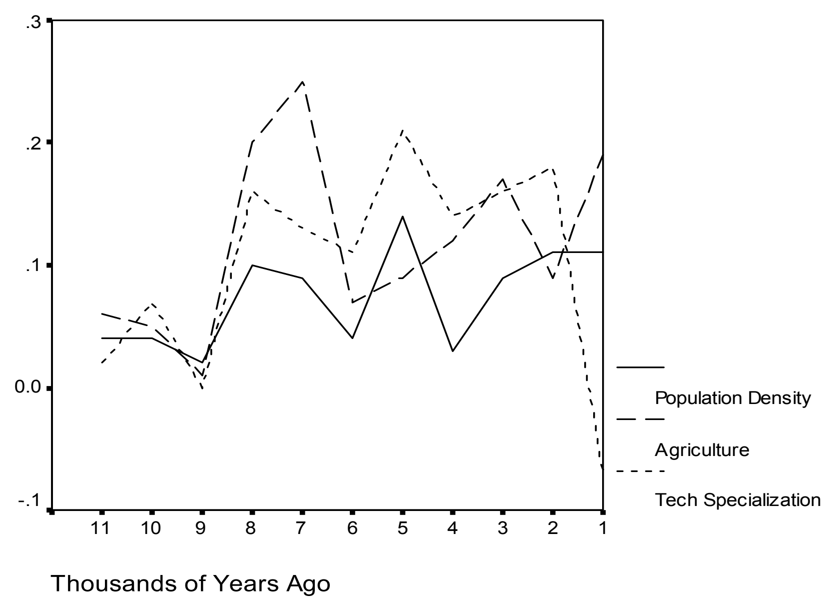


Figure 3.A.2 Time Series Plot of Population Density, Agriculture, and Technological Specialization, Differenced to De-trend the Series.



The extent of inter-correlation between population density, agriculture, and technological specialization is shown more clearly in Figures 3.A.3, 3.A.4, and 3.A.5. These are cross-correlation graphs for the three variables, illustrating the cross-correlation of each with the others through time. There is a strong and regular relationship between all three. None of these variables appears to directly cause change in the others, at least not in the time scale (1000 years) used here. Within that time period, all appear to change together, and none appears to be a clear "prime mover" of cultural evolution. The lesson here may be that there are not single "prime mover" variables underlying cultural evolution.

Figure 3.A.3 Cross-Correlation of Population Density and Agriculture

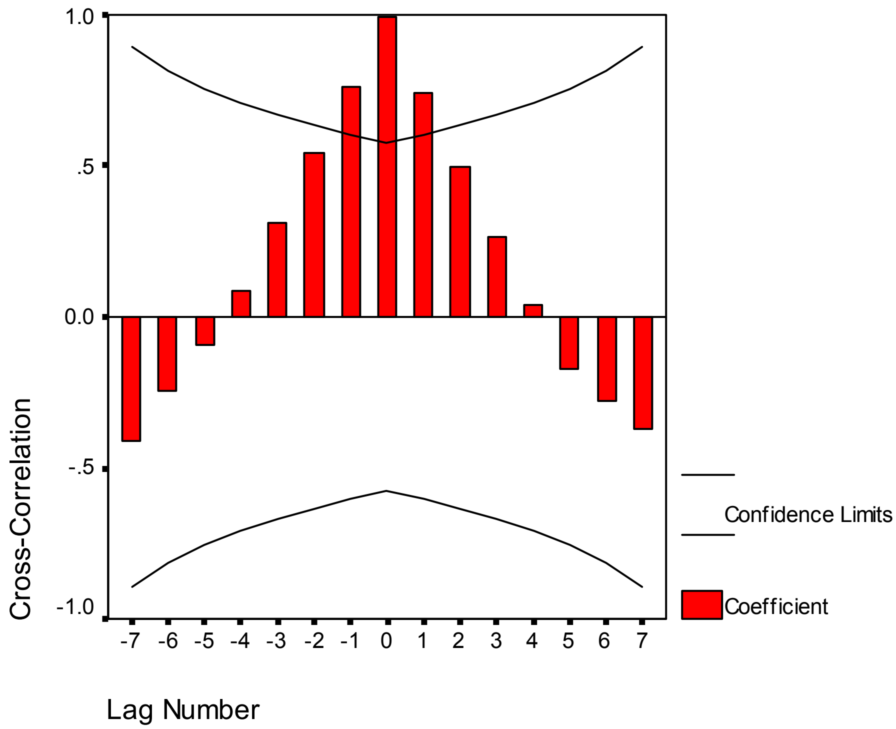


Figure 3.A.4 Cross-Correlation of Population Density with Technological Specialization.

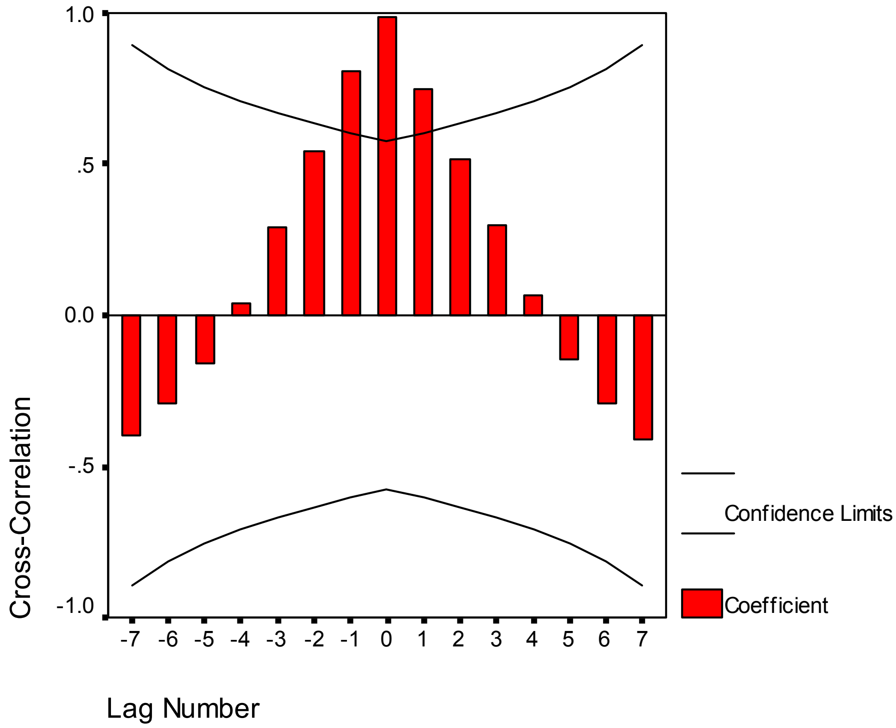
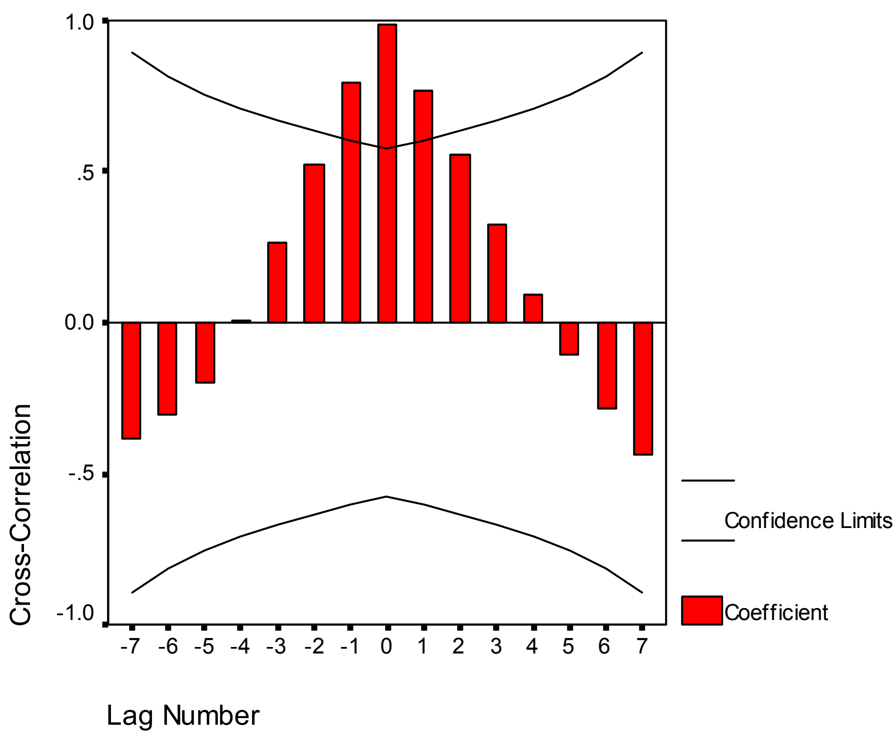


Figure 3.A.5 Cross-Correlation of Agriculture with Technological Specialization



On the other hand, while none of these variables seems a clear "prime mover" of change, shortening the time period used in the analysis to 100 years or so may allow us to show one of these variables to be causal in relation to the others. I have not done so here, because I believe the ACE data are too coarse for such a detailed analysis. The ACE data are able to illustrate broad patterns of cultural evolution, but may not be refined enough to allow for close temporal relationship between variables to be resolved. I suggest this is precisely the type of problem that the more detailed information available through the HRAF Collection of Archaeology may be able to address.

B. Causal Modeling

The time-series do not appear to provide enough information to determine the causal relationships between population density, agriculture, and technology. A different method of examining causal relationships--causal modeling--may provide a means to determine whether and how these variables effected and perhaps caused change in the others. Causal modeling is a method used to establish quantitative measures of causal connection between variables. It does not provide a means to *prove* that change in one variable causes change in another, but rather, allows for various assumptions about the possible directions of causality to be evaluated. In other words, it provides a way to test models of causal connection, but does not independently identify causality (see Birnbaum 1981).

Figure 3.B.1 shows a simple model for the relationships between population density, agriculture, and technology. The correlation coefficients are the same as those presented in Table 3.A.1. Directionality is not illustrated here, because we have yet to identify causal directions. One way to do so is to examine the partial correlation coefficients of between these variables when controlling for time, and when controlling for the other variable (an iterative method often referred to as the Simon-Blalock Technique--see Asher 1983). Partial correlations are presented in Figures 3.B.2 and 3.B.3.

Figure 3.B.1 Correlations Between Population Density, Agriculture, and Technological Specialization

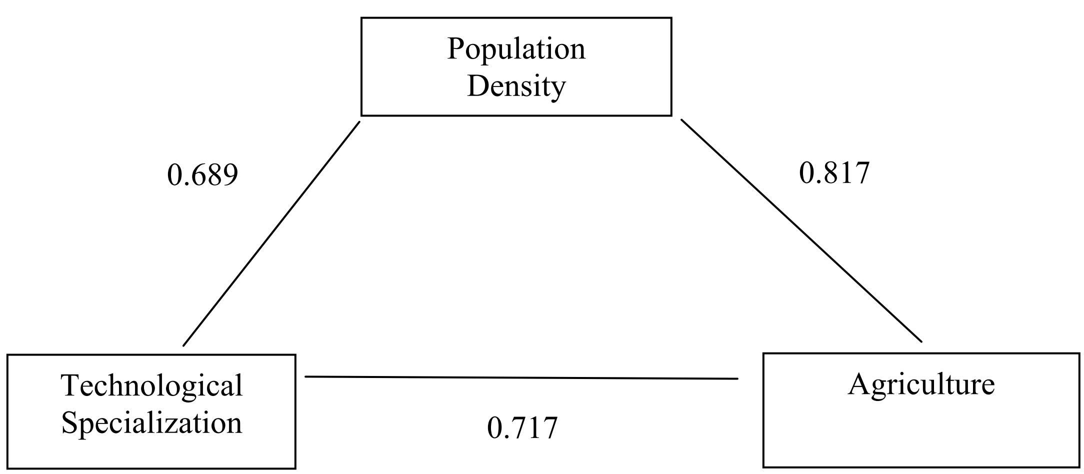


Figure 3.B.2 shows that controlling for date has little effect on the connections between these variables; that is, variation seems uninfluenced by date. This is not surprising given the time-series analyses I've already presented. The three variables appear to change in unison regardless of the time period. Figure 3.B.3 is more interesting, as the correlation between population density and technological specialization drops precipitously when controlling for agriculture, much more than the other correlations drop when controlling for the third variable.

Figure 3.B.2 Partial Correlations Between Population Density, Agriculture, and Technological Specialization, Controlling for Date

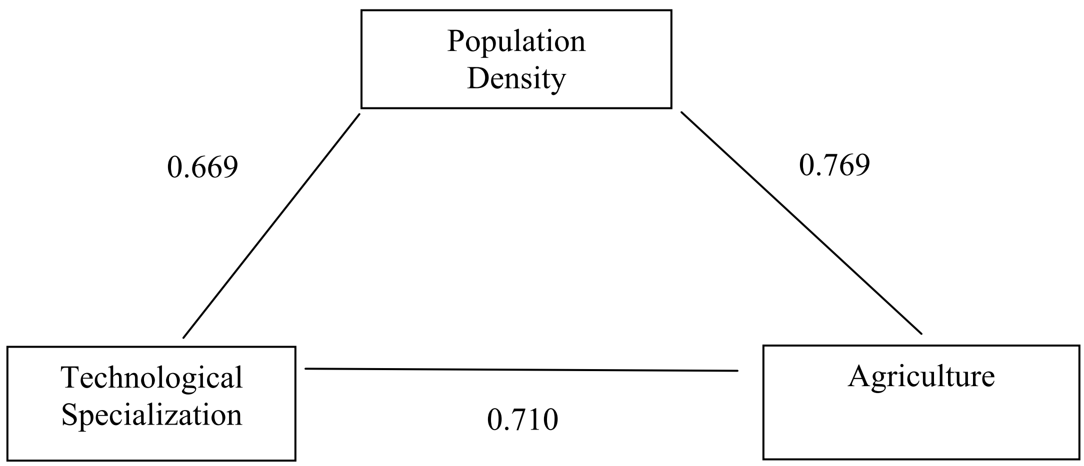
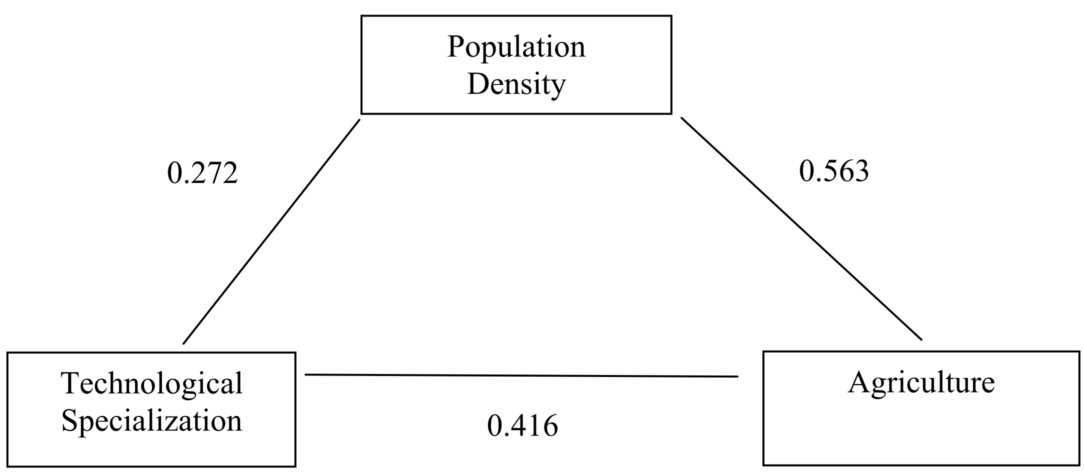
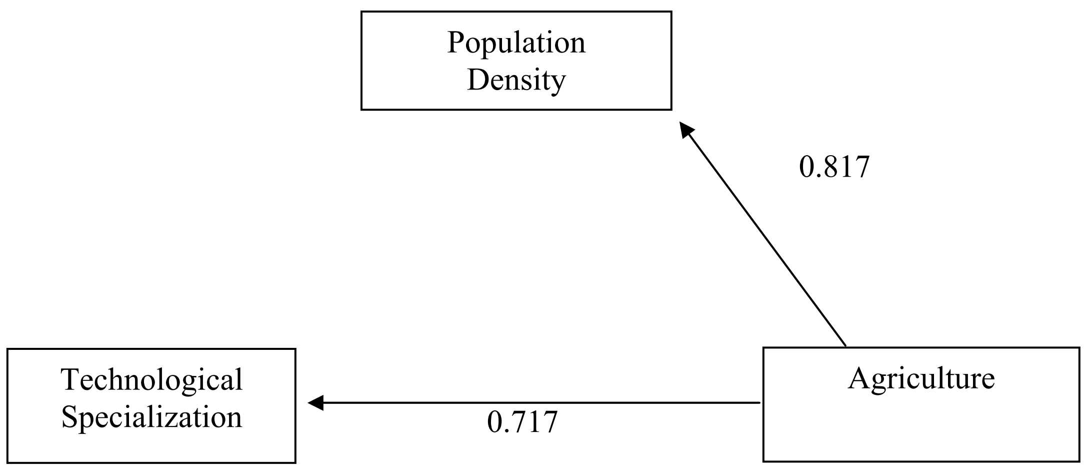


Figure 3.B.3 Partial Correlations Between Population Density, Agriculture, and Technological Specialization, Controlling for the Other Variable



Using basic rules of thumb for causal modeling (e.g. Davis 1985), we arrive at the parsimonious model presented in Figure 3.B.4. First, because the correlation between population density and technological specialization dropped so precipitously when controlling for agriculture, we can make the assumption that changes in agriculture may be causally related to changes in both population density and technological specialization, and that the correlation between them (without controlling for agriculture) is largely spurious (but see the discussion below). Second, because we know that agriculture is required to sustain high population densities, and that ceramics are rare and metal work unknown in non-agricultural societies, we can assume that agriculture must causally precede at least some changes in the other two variables. Thus, we end up with a causal model in which changes in agriculture cause change in population density and change in technological specialization.

Figure 3.B.4 A Parsimonious Model of the Relationship Between Population Density, Agriculture, and Technological Specialization



If change in agriculture causes change in the other two variables, then why is there still a statistically significant correlation between population density and technological specialization even when controlling for agriculture? The answer is probably that there is a strong, underlying variable that is uncontrolled for here. It is not simply date, as controlling for date does not change the correlation coefficients very much. Rather, it is probably something we might refer to as cultural evolution--a regular process of change effecting all the variables and which we have already seen in, for example, Figure 2.B.3. The strength of that underlying variable--cultural evolution--is significant (R-squared of 0.324 for Figure 2.B.3) and affects all the variables. Hence we must assume that, without controlling for cultural evolution, there will always remain a strong correlation between two culture variables on the ACE data set. What we need to look for is not absence of correlation, but rather significant declines that suggest all other factors aside from cultural evolution have been controlled.

It appears that agriculture is the more causally important variable of the three we have examined here, suggesting that both population pressure (e.g. Cohen 1977) and technological determinism (for example, elements of both Harris 1979 and White 1959) models of cultural evolution are less satisfactory than models which propose changes in subsistence affecting changes in other areas of culture (e.g. Steward 1955). It also appears that there is a powerful, underlying variable not accounted for in any of these models, a variable we might refer to simply as cultural evolution.

C. Log-Linear Modeling

Log-linear modeling provides an alternative method of examining causal relationships that is more appropriate for the ordinal data used here. Log-linear modeling is essentially a form of causal modeling like that used above, but explicitly designed for use with categorical data. Log-linear modeling allows variables with multiple categories to be used to calculate the odds (i.e., the ratio of favorable to unfavorable responses) that a change in one variable will cause a change in the other (Knoke and Burke 1980).

A log-linear model is basically a statement of the expected frequencies in the cells of a crosstabulation. To assess how well a given model fits the data one determines how well the cell frequencies expected in the model approximate the observed frequencies, with goodness-of-fit calculated as odds and odds ratios (often called likelihood ratios). Table 3.C.1 presents a group of log-linear models for population density, technological specialization and agriculture, along with their associated likelihood ratios (L^2). By convention, interaction between two variables is noted with a * in describing log-linear models, and non-interaction with a +. Thus, the relationship between population density, technological specialization, and agriculture presented in Figure 3.B.1 is represented in Table 3.C.1 by model 2, while the parsimonious causal model presented in Figure 3.B.4 is represented by model 3.

Table 3.C.1 Log-Linear Models for Population Density, Technological Specialization, and Agriculture.

Model	L^2	df	p
1. {D*T*A}	0	0	-
2. {D*A}+{T*A}+{D*T}	11.07	8	0.198
3. {D*A}+{T*A}	34.66	12	0.000
4. {D*A}+{D*T}	41.50	12	0.000
5. {T*A}+{T*P}	104.07	12	0.000
6. {D*A}+T	203.60	16	0.000
7. {T*A}+D	266.17	16	0.000
8. {D*T}+A	273.02	16	0.000
9. {D}+{T}+{A}	435.11	20	0.000

Unlike ordinary evaluation of contingency tables with statistics like chi-squared, where one usually seeks to find deviations from expected patterns, in log-linear analysis one seeks the best match with expected patterns. Hence, in looking at a table like 3.C.1, one seeks low values of L^2 relative to the degrees of freedom rather than vice-versa. Model 2 has the lowest value of L^2 (except for the “saturated” model 1, which is only used as a baseline in evaluating other models) and highest degrees of freedom. Indeed, it is the only model that shows non-significant deviance from expected values. However, a critical aspect of log-linear analysis is the evaluation of alternative models. Although model 2 appears to best fit the data, it is not the most parsimonious, nor does it match with our theoretical expectations derived from the causal modeling performed in the section 3.B. To better evaluate the models, one must examine the changes from model to model in L^2 and degrees of freedom in order to determine whether those changes are statistically significant.

Table 3.C.2 shows the change in likelihood ratios (L^2) and degrees of freedom for four model comparisons. The changes are the simple difference in the values of L^2 and degrees of freedom for each model, while p can be calculated from a standard chi-squared table using the values of ΔL^2 and Δdf. Looking at these it would appear that model 2 may be the most parsimonious. Model 2 shows a significant change in L^2 relative to the change in the degrees of freedom when compared with model 3, and it provides an acceptable fit with the expected values. On the other hand, the change in L^2 from model 2 to the "saturated" model 1 is not statistically significant. Hence, model 2 appears to be the most parsimonious.

Table 3.C.2 Evaluation of the Improvement of Fit for Log-Linear Models for Population Density, Technological Specialization, and Agriculture.

Model Comparison	ΔL^2	Δdf	p
2-1	11.07	8	0.198
3-2	23.59	4	0.000
6-5	99.53	4	0.000
9-8	162.09	4	0.000

Causal modeling suggested that the relationship between population density and technological specialization was not important and could be dropped from the model. Log-linear modeling suggests that opposite, that including the interaction between population density and technological specialization significantly increases the fit of the model despite the loss of degrees of freedom.

Why is there a difference between the results of these exercises in modeling? The simple answer may be that the techniques used are different and therefore yield somewhat different results. A more satisfactory answer probably rests in the data themselves. As I mentioned earlier, the ACE data are coarse. They were developed to illustrate broad patterns of cultural evolution, and attempting to use them to differentiate the comparative effects of one variable on another might be overextending their capabilities. Finally, it may be that the results of the time-series analyses gave the clearest picture--that these variables mutually affect one another over short periods of time and it may be impossible to identify a clear causal or "prime mover" variable among them.

D. Conclusion

Cultural evolution appears to be multi-causal, and as we move towards explaining cultural evolution, we must avoid the desire to overly simplify what appears to be a complex, multivariate set of relationships. The *Atlas of Cultural Evolution* provides a set of data to begin exploring this complex set of relationships. I hope that the discussion in section 3 has also provided some background to the various analytical techniques that might be used in conjunction with the ACE data set to examine cultural evolution. I have used these data to begin the exploration of cultural evolution through the empirical methods of archaeoethnology (e.g. Peregrine 2001b), and it is my hope that by providing these data to a larger audience of researchers, our combined efforts may lead to significant insights into the patterns and processes of cultural evolution.

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5. MAPS

Archaeological traditions have both spatial and temporal dimensions. Each tradition's temporal dimension is provided in the ACE data set by a start date, end date, midpoint, and a set of time series variables (see Section 6). The spatial dimension for each tradition is also provided, in a crude form, in the ACE data set by an east and north grid coordinate, which together identify a 1000 km square grid unit within which the midpoint of the geographical area of the tradition is located. The maps that follow provide a more accurate representation of the spatial dimension of each archaeological tradition. The maps are included in electronic form on the accompanying CD, along with the *MapMaker Gratis* software package with which the maps can be displayed, printed, and modified.

A. Maps of the World's Archaeological Traditions

Figure 5.A.1 -- The World's Archaeological Traditions 2 Million Years Ago

Figure 5.A.2 -- The World's Archaeological Traditions 500,000 Years Ago

Figure 5.A.3 -- The World's Archaeological Traditions 100,000 Years Ago

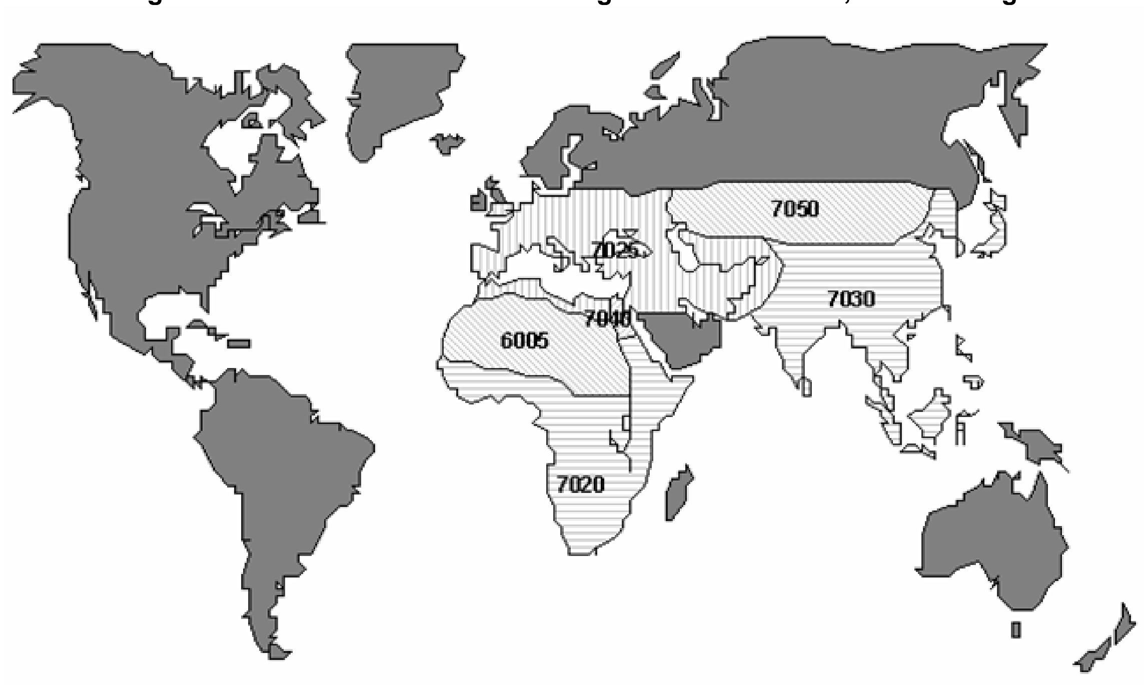


Figure 5.A.4 -- The World's Archaeological Traditions 50,000 Years Ago

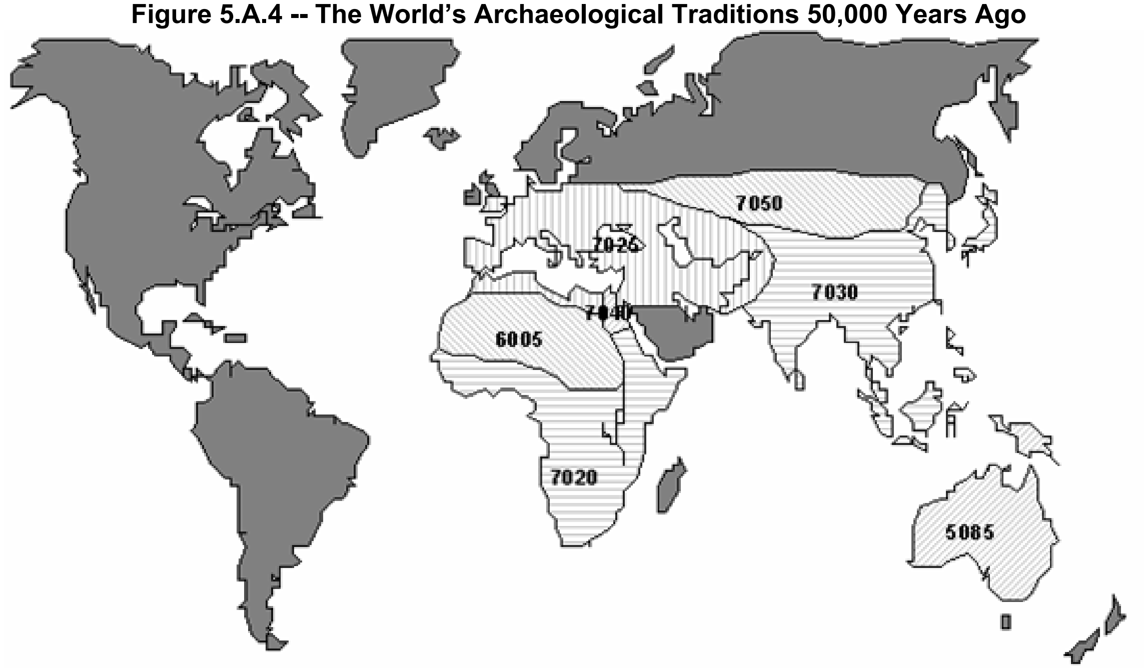


Figure 5.A.5 -- The World's Archaeological Traditions 40,000 Years Ago

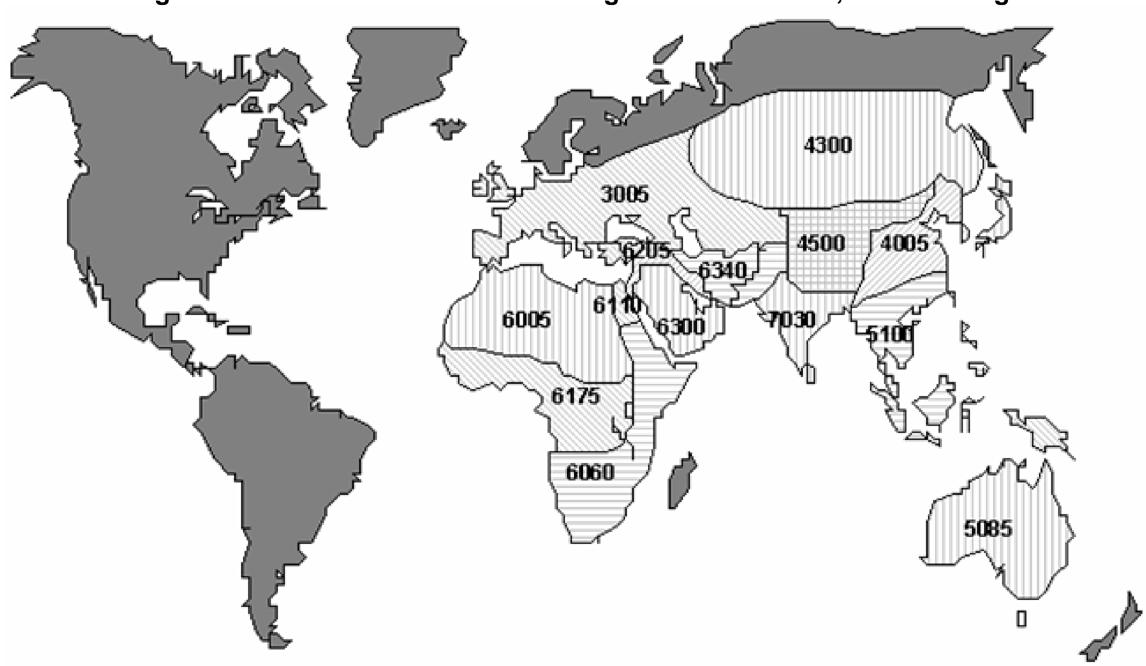


Figure 5.A.6 -- The World's Archaeological Traditions 30,000 Years Ago

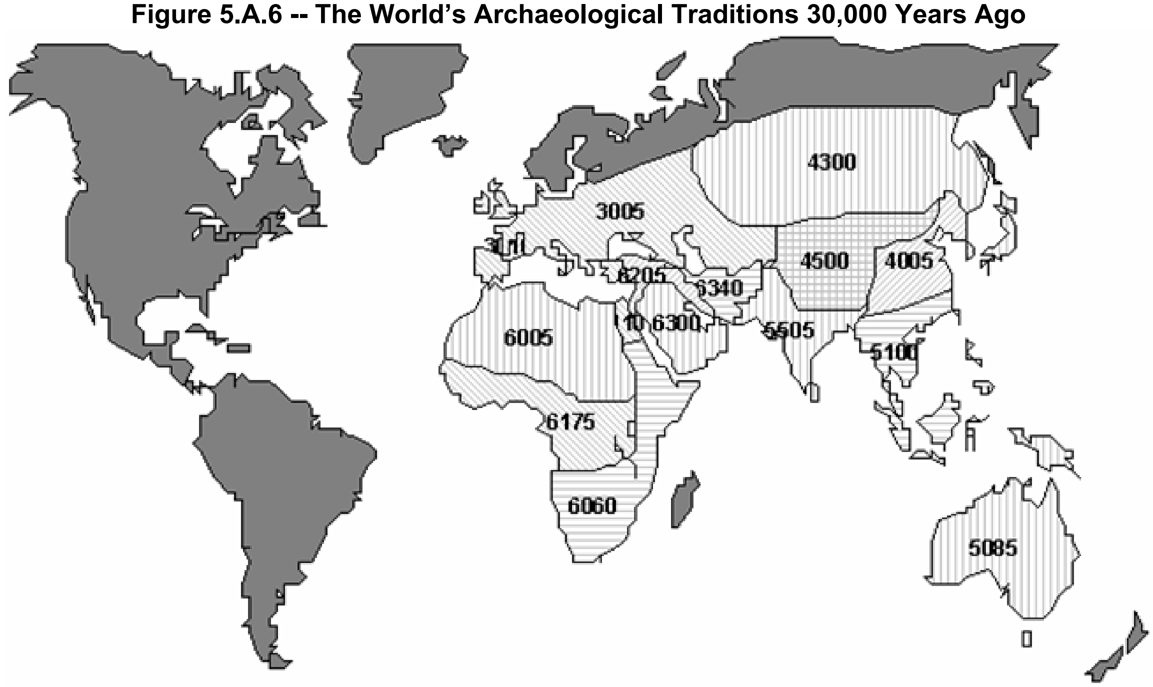


Figure 5.A.7 -- The World's Archaeological Traditions 20,000 Years Ago

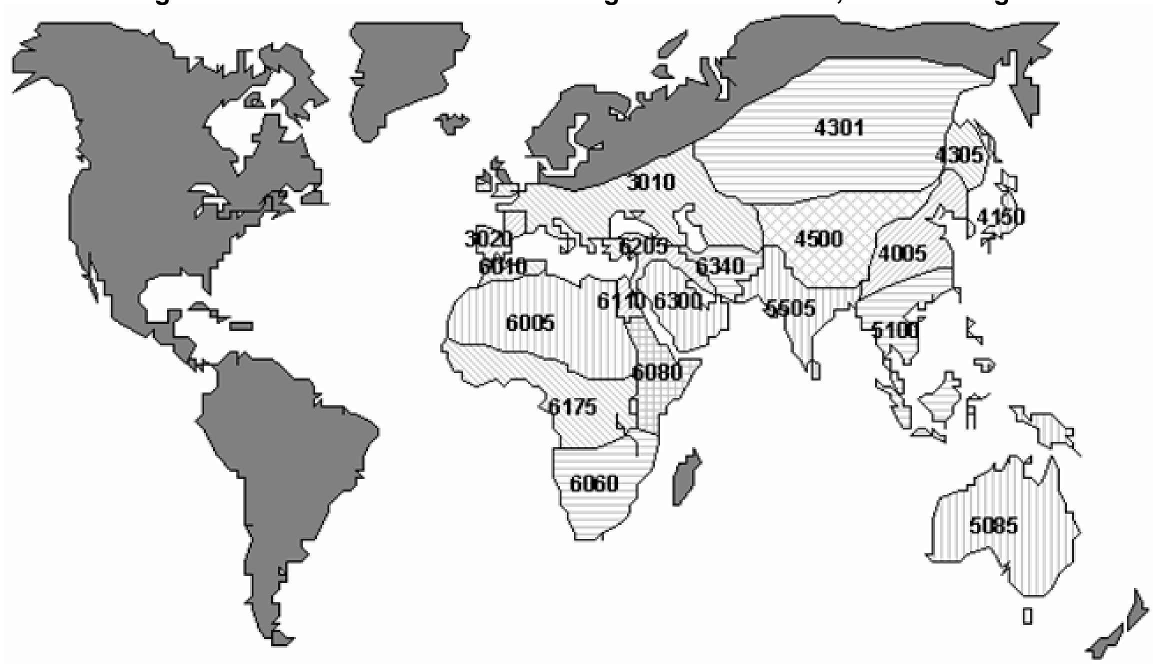


Figure 5.A.8 -- The World's Archaeological Traditions 12,000 Years Ago

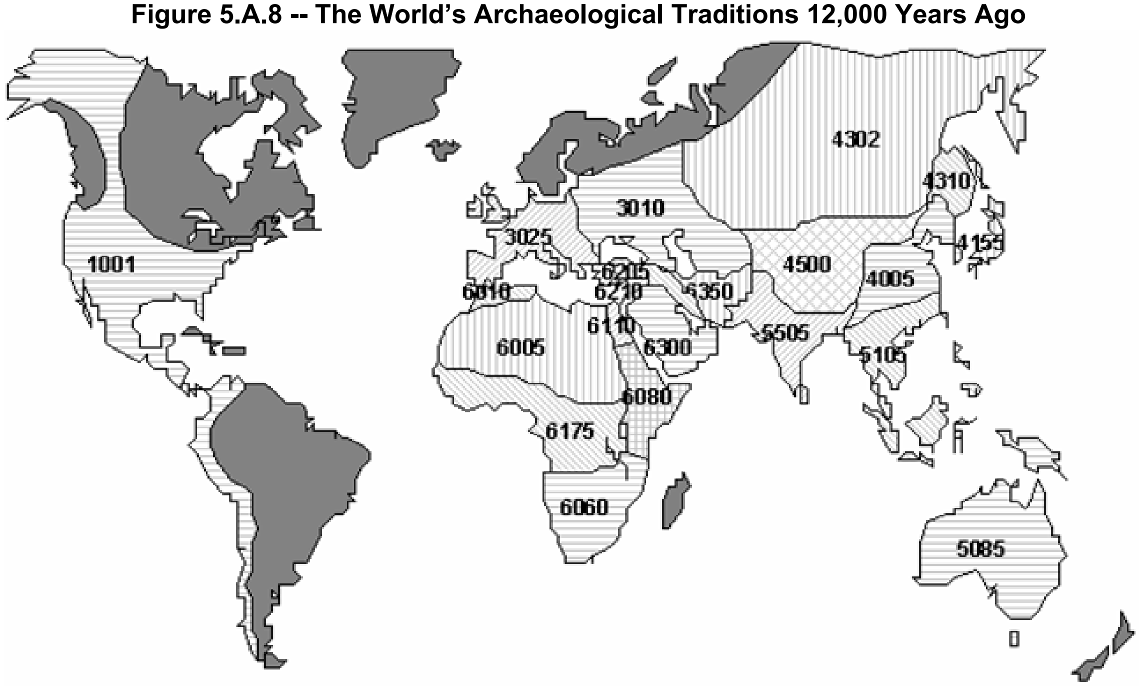


Figure 5.A.9 -- The World's Archaeological Traditions 11,000 Years Ago

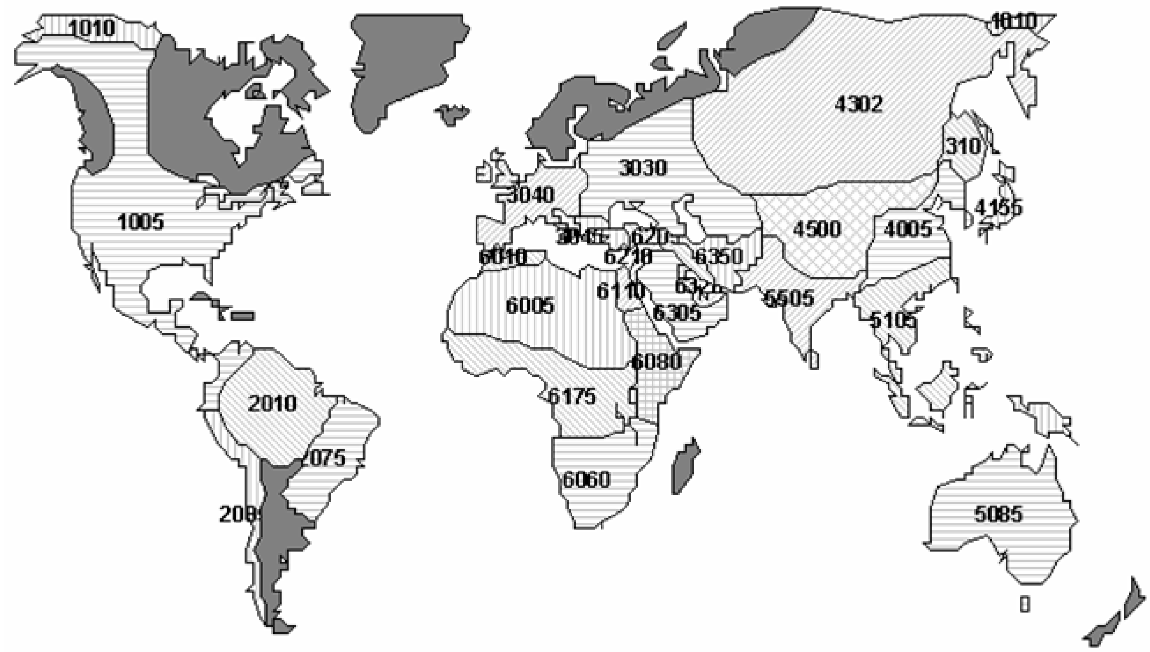


Figure 5.A.10 -- The World's Archaeological Traditions 10,000 Years Ago

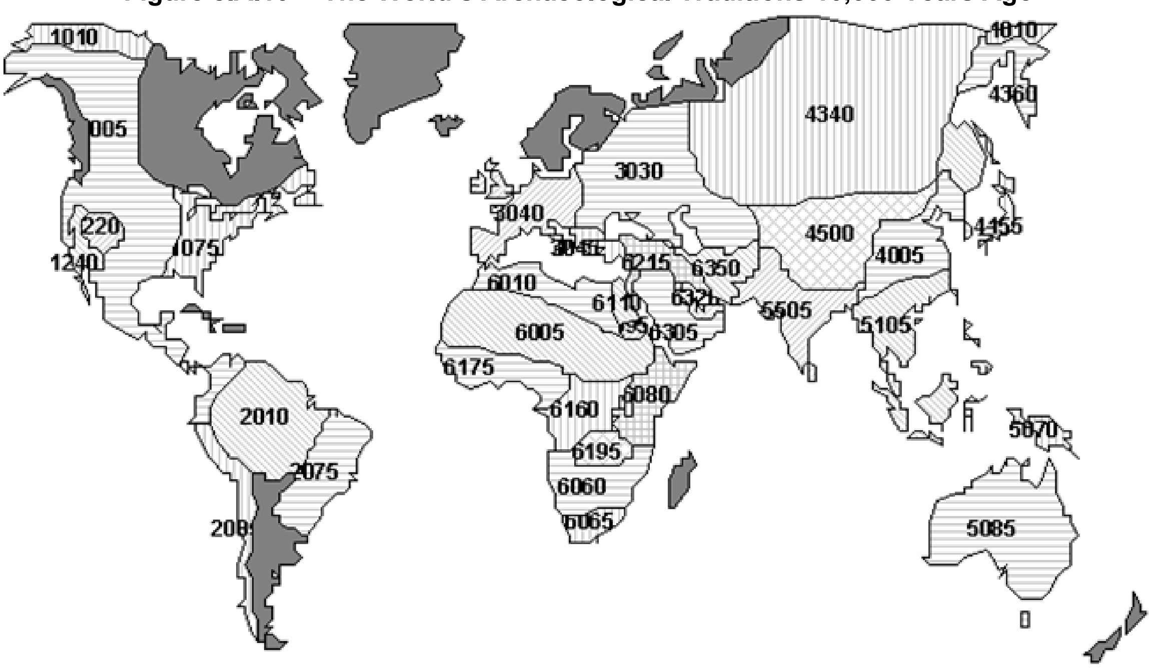


Figure 5.A.11 -- The World's Archaeological Traditions 9,000 Years Ago

Figure 5.A.12 -- The World's Archaeological Traditions 8,000 Years Ago

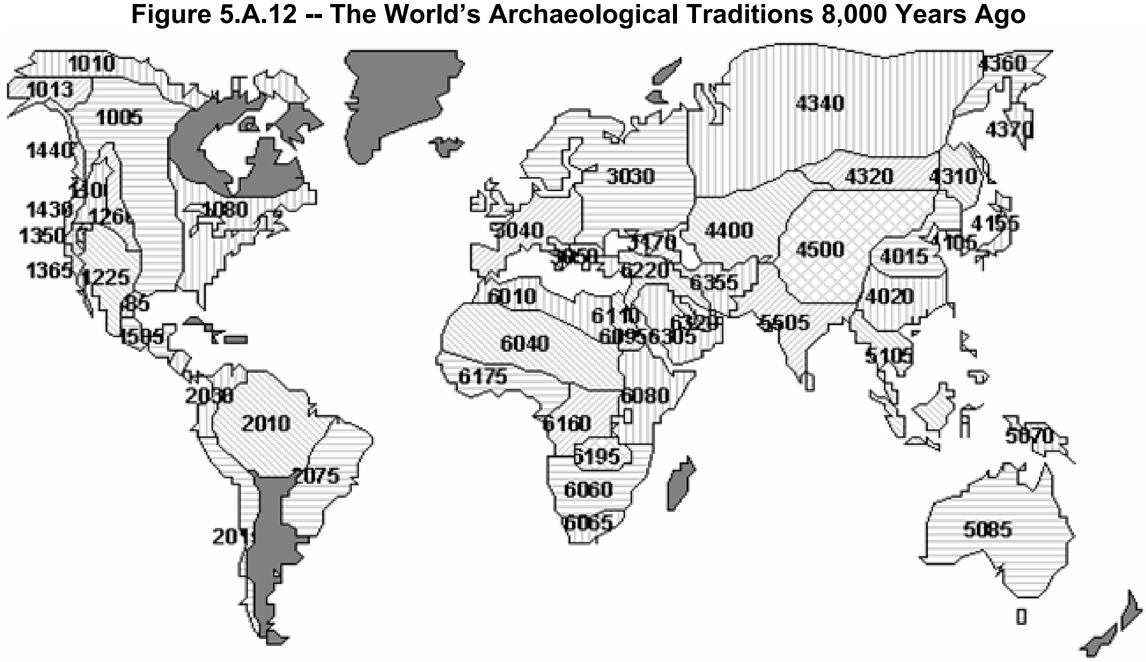


Figure 5.A.13 -- The World's Archaeological Traditions 7,000 Years Ago

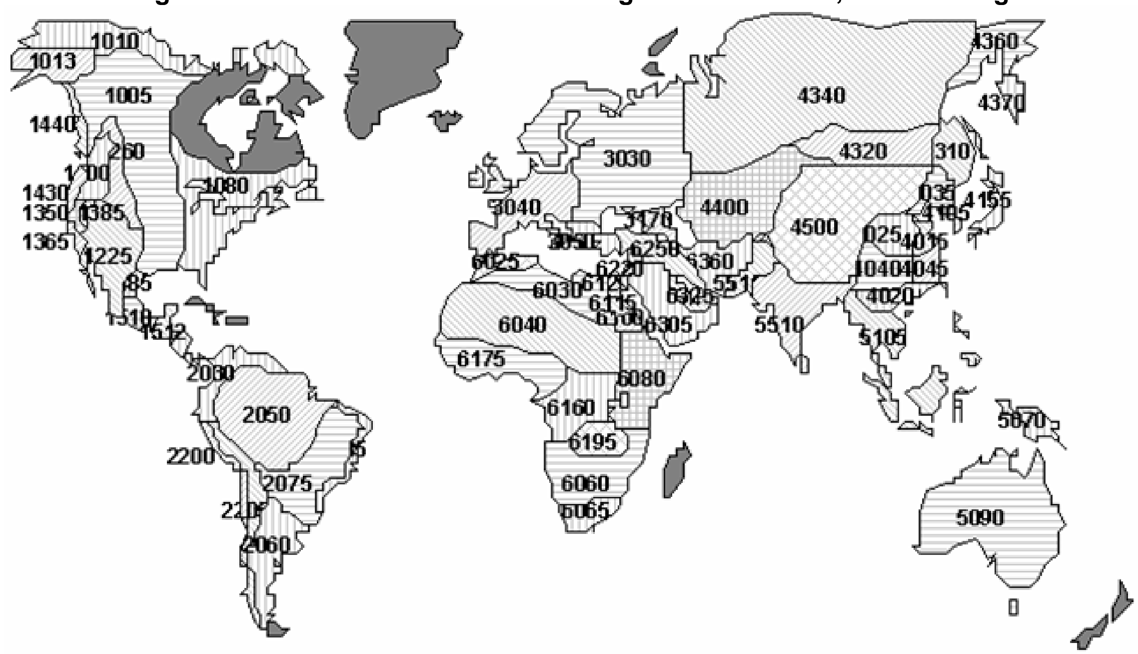


Figure 5.A.14 -- The World's Archaeological Traditions 6,000 Years Ago

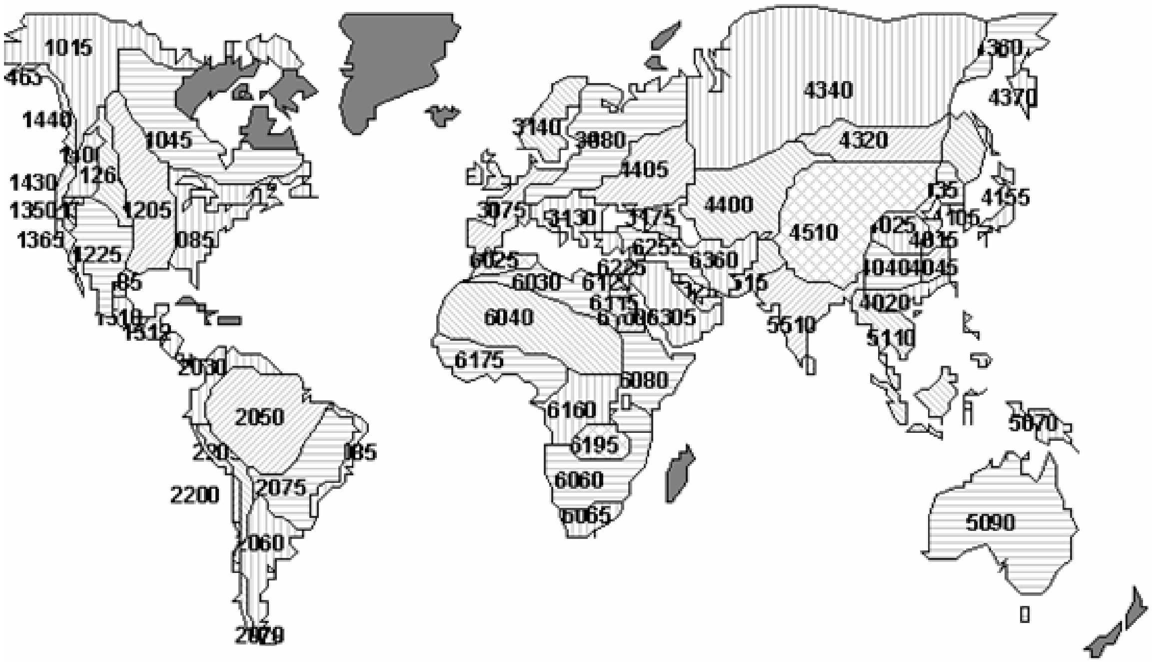


Figure 5.A.15 -- The World's Archaeological Traditions 5,000 Years Ago

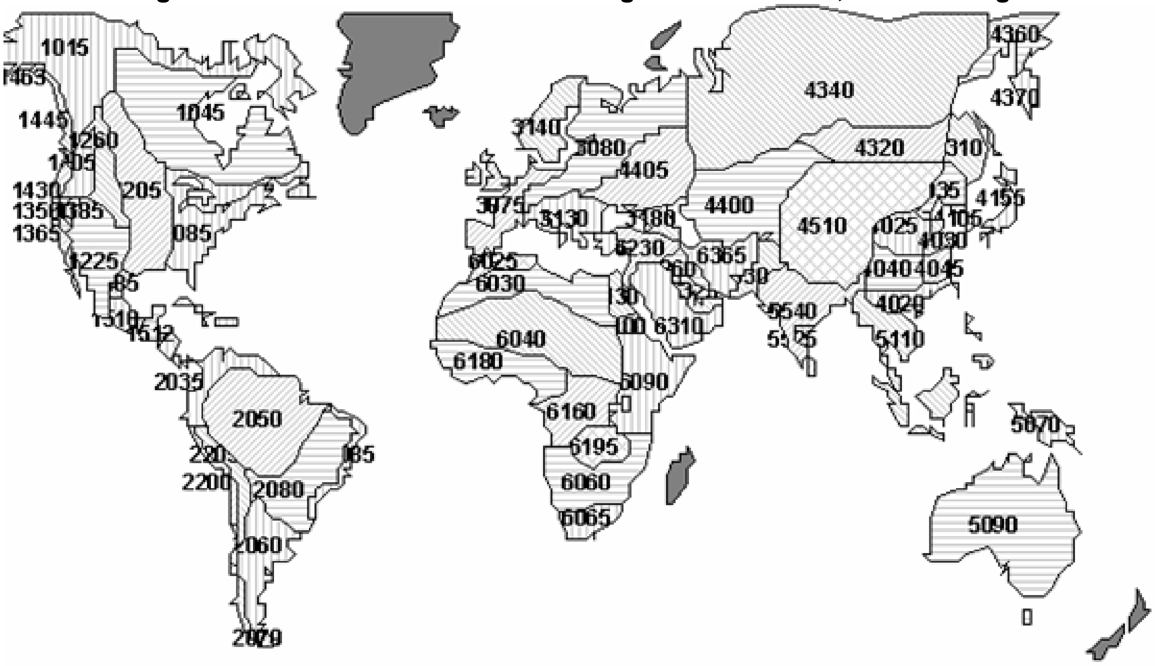


Figure 5.A.16 -- The World's Archaeological Traditions 4,000 Years Ago. (Note that Southern Mesopotamia has moved into the historic record and is dropped from the data set.)

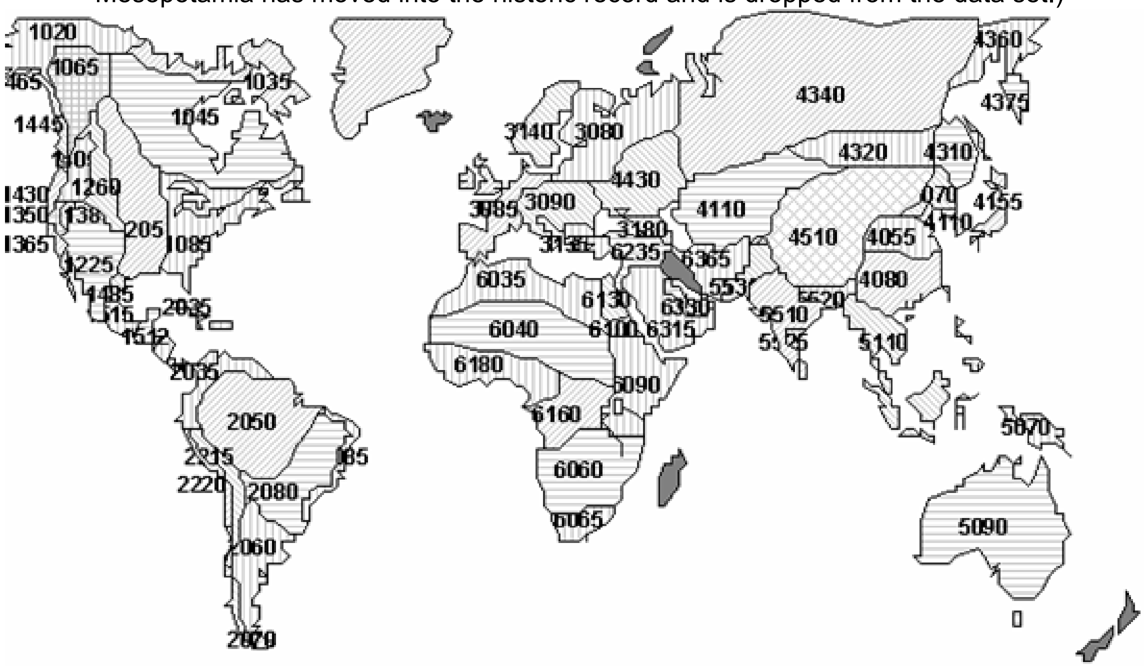


Figure 5.A.17 -- The World's Archaeological Traditions 3,000 Years Ago (Note that Zhou China and the Greco-Roman world have moved into the historic record and are dropped from the data set.)

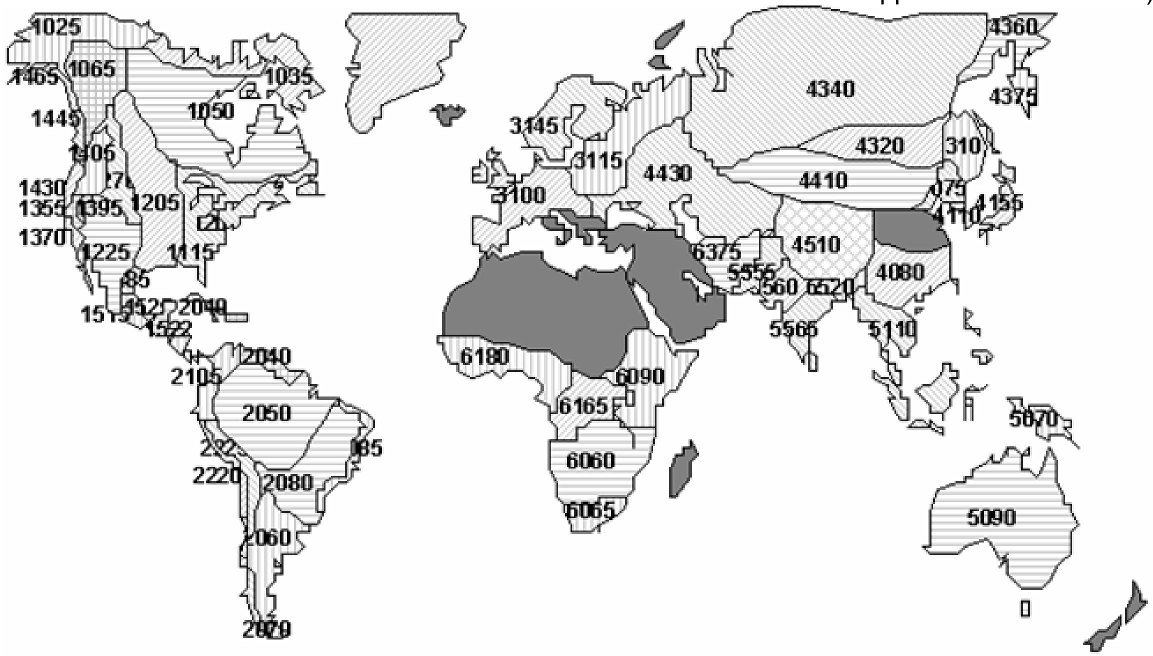


Figure 5.A.18 -- The World's Archaeological Traditions 2,000 Years Ago (Note that much of Eurasia is historic and not included in the data set.)

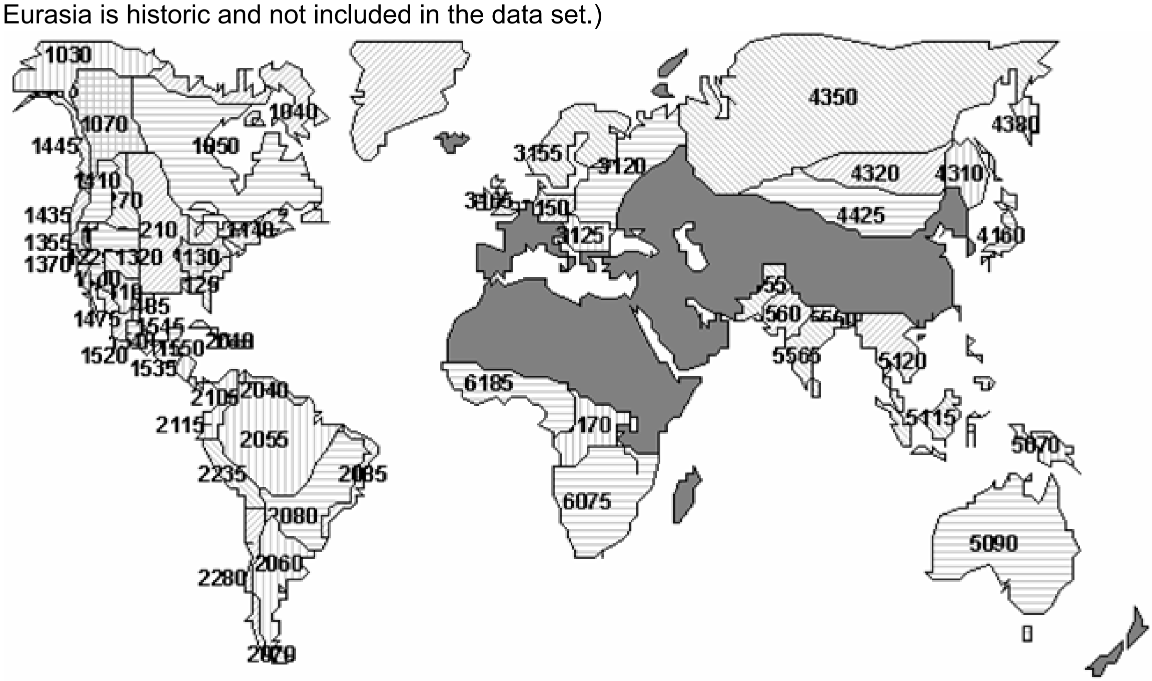
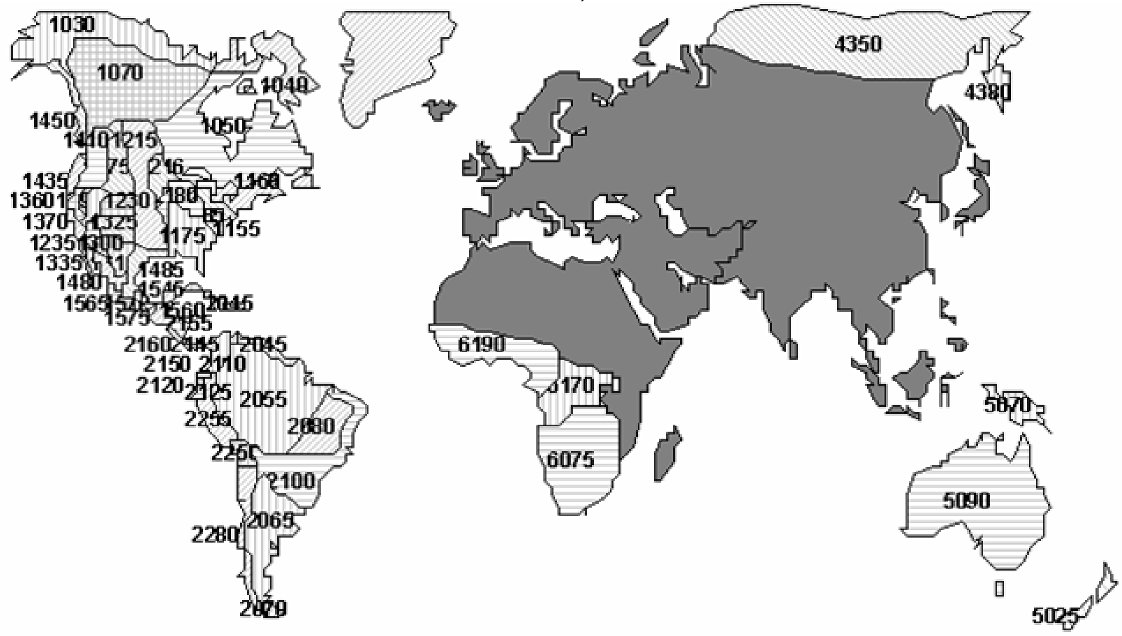


Figure 5.A.19 -- The World's Archaeological Traditions 1,000 Years Ago (Note that much of Eurasia is historic and not included in the data set.)

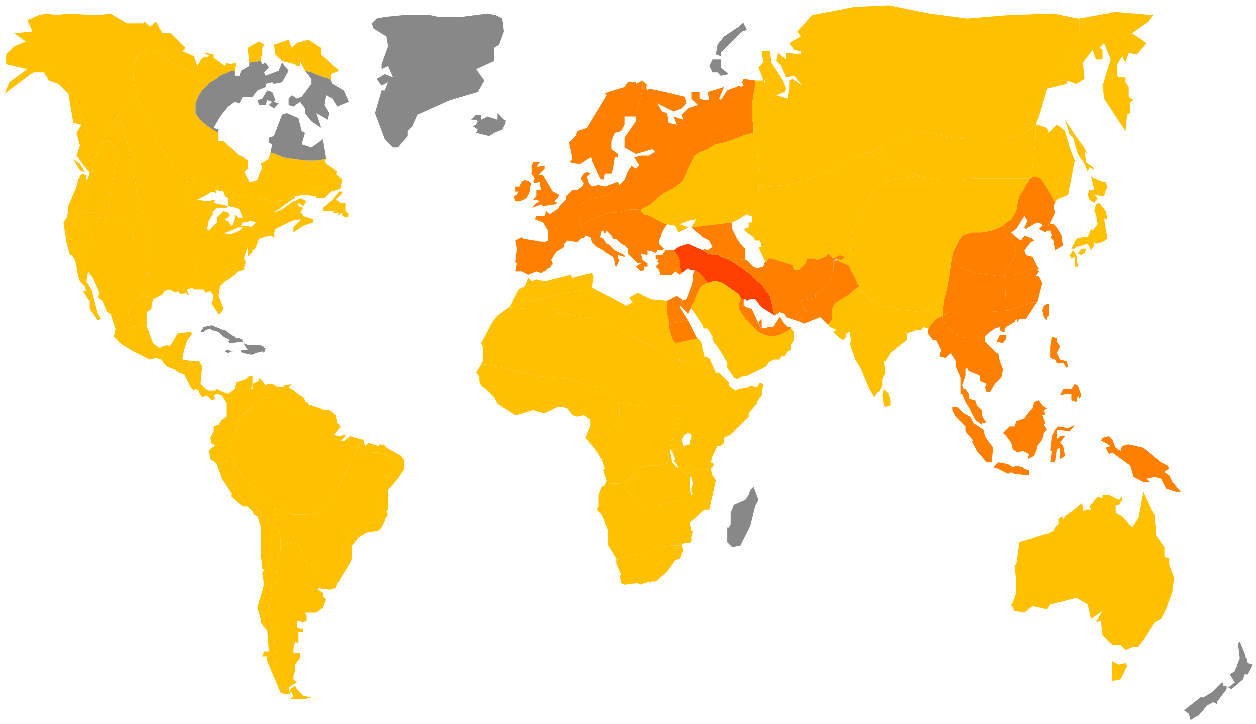


B. Interactive Maps Using *MapMaker Gratis*

Included on the accompanying CD is a copy of the *MapMaker Gratis* software package, a simple Geographical Information System (GIS) designed to allow novice users to create and manipulate maps in sophisticated ways. The ACE maps presented above were produced using *MapMaker Pro*, a more sophisticated version of the basic *MapMaker* package included here, but a user can display, edit, and print any of these maps with either version. In addition, *MapMaker* allows data from the ACE data set to be displayed geographically. One might produce, for example, a map showing population density values for a given date in the past, as illustrated in Figure 5.B.1 (next page).

MapMaker Gratis is freeware, but its creators invite users to visit the MapMaker website (www.mapmaker.com) to consider purchasing a full version of the software and to examine the other mapping resources they have. The MapMaker website includes tutorials and other user information for the *MapMaker* software family, as well as links to other mapping sites and data repositories.

Figure 5.B.1 Population Density Values for the World 6,000 Years Ago.



To use *MapMaker Gratis*, you need first to install it on your computer. Copy the file mmZip.exe to your hard disk, then double-click on it and follow the instructions. Files will automatically be unzipped and installed in c:\MapMaker, although you can specify another location if you wish. A manual is available and can be downloaded (along with program updates) from the MapMaker website (www.mapmaker.com).

Once *MapMaker Gratis* is installed, you can use it to display, edit, and print any of the ACE maps, or indeed, to create your own maps. To open a map, launch *MapMaker Gratis* and select "File" and "Open." You will see a screen like Figure 5.B.2 (next page).

Maps like those presented above are called drawings in *MapMaker*, and have the extension .dra. Navigate using the "Currently selected directory" window to the CD which accompanied this journal and to the \AceMaps directory. *MapMaker* drawing files for the ACE maps are located in this directory. Select a drawing file and double-click on it to open it. A second screen, like that shown in Figure 5.B.3, will appear.

Figure 5.B.2. ***MapMaker*** **Screen Showing Maps (Drawing Files) Available to Open.**

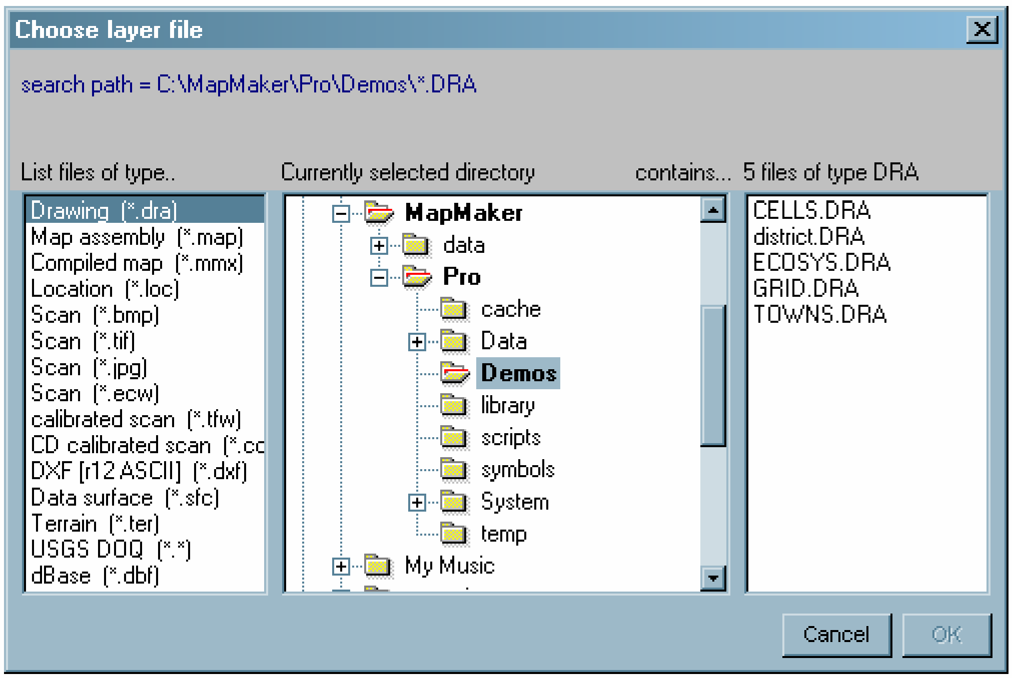
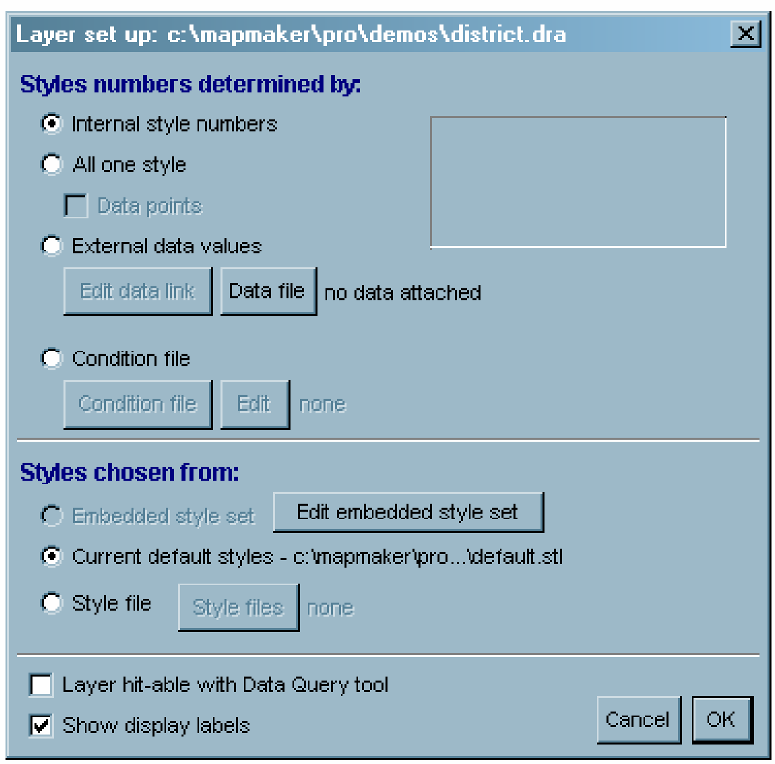


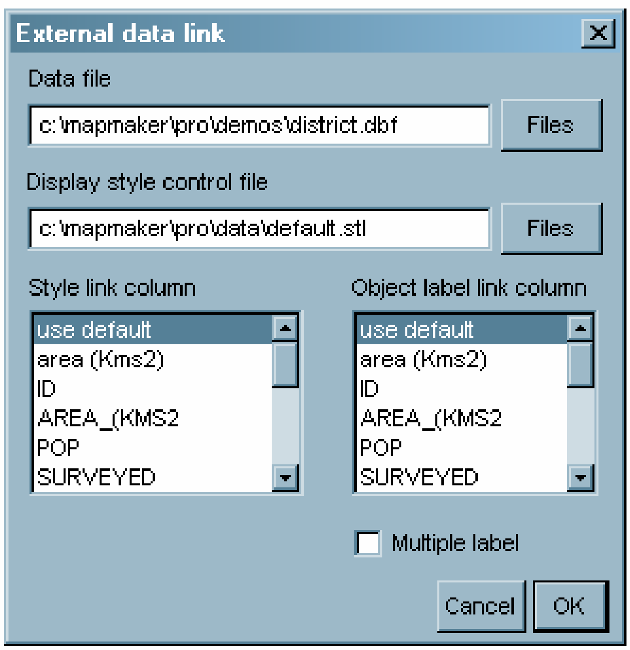
Figure 5.B.3. ***MapMaker*** **Screen Showing Display and Data Link Options.**



MapMaker provides many different ways to display maps and data by linking drawing files to data files and style files. This screen provides a number of options, only two of which I will note here. First, to link the ACE maps to the ACE data set, click the button next to "External data values" and open the file Acemap.dbf in the \AceMaps directory. A screen like that shown in Figure 5.B.4 will appear. To map a variable, select it in the "Style link column." To label the traditions, choose either the name or number variables in the "Object label link column."

Second, *MapMaker* uses style files, with the extension .stl, to create the appearance of a given map. To make a map look like those presented above, click the button next to "Style file" and select the Ace.stl file. Finally, you will probably want to select the check box next to "Layer hit-able with Data Query tool." Doing so will allow you to click on the geographic area of an archaeological tradition and view the data associated with it. When you click the "OK" button your map will be displayed. You will not be able to modify or alter the map. In order to alter a map you need to load it as a "Live Layer," but I suggest you become familiar with *MapMaker* and read the manual thoroughly before beginning to work with live layers.

Figure 5.B.4. *MapMaker* Data Link Screen.



Part B: **Live link to** http://eclectic.ss.uci.edu/Archaeo/14-1b-peregrine.pdf
Back to top http://eclectic.ss.uci.edu/Archaeo/14-1a-peregrine.pdf
Back to Archaeo home http://eclectic.ss.uci.edu/Archaeo/
World Cultures home http://eclectic.ss.uci.edu/~drwhite/worldcul/world.htm