Global Change from Local Decisions: An Archaeologist's Perspective

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Abstract

Archaeology provides time depth to considerations of cultural change at global and local levels. I focus on the Neolithic Revolution, which swept the globe from 8000 to 3000 bc (uncalibrated radiocarbon years). Although agriculture became widespread over a relatively brief period, it developed independently in many places. No single factor or set of factors has been identified to explain this global phenomenon. When the scale of analysis is changed to the local level, diversity characterizes the reasons for both agricultural invention and adoption. I consider patterns of adoption by Southern Scandinavian societies, which exhibit a complex, sedentary hunter-gatherer lifeway, and early Irish societies, which conform to a simple, mobile hunter-gatherer model. I suggest that a new paradigm may be needed to explain global patterns that emerge from diverse, local decisions. I conclude with a brief critical discussion of the Santa Fe Institute's approach to the study of emergent complex phenomena.

Keywords: *archaeology, complexity, cultural change, Ireland, Neolithic*

Introduction

In *Personal Helicon* (Heaney 1969), a poem about childhood and discovery, Seamus Heaney writes:

Now, to pry into roots, to finger slime,
To stare, big-eyed Narcissus, into some spring
Is beneath all adult dignity.
I rhyme
To see myself, to set the darkness echoing.

The poet creates a mirror with his rhymes. In a way, archaeology is like "hands-on" poetry. Its purpose is to "pry into roots" of humanity, "to set the darkness echoing" so that we may see ourselves better as a species.

Archaeology has been termed the diachronic study of cultural change— in other words, archaeologists try to understand cultural change across large segments of time: 1,000, 10,000, sometimes millions of years. The view from that distance can shed some interesting light on human affairs.

Often the most intriguing examples of cultural change are the ones that happen on a large scale. A relatively recent example would be an incredible society that emerged in the southwestern United States about 900 years ago. The Anasazi culture seems to erupt from the desert floor with settlements, ceremonies, long-distance exchange — in a word, complexity — and then sink back to virtual obscurity in only about two hundred years (Cordell 1984; Doyel 1992; Gumerman and Gell-Mann 1994).

Sometimes the scale and pace of cultural change can be even more impressive. In this paper, I discuss the transition to agriculture, a global pattern of cultural change commonly referred to as the Neolithic (or farming) Revolution. It is probably one of the most significant events in human history. It irreversibly changed human perceptions of their world and, like Thomas Kuhn's (1970) idea of a scientific revolution, it is impossible to point to one source for its beginnings. Likewise, it has been impossible to point to one explanation or even a discrete set of explanations for its occurrence.

Global Change and Local Diversity: The World-Wide Transition to Agriculture

From about 8000 to 3000 bc (uncalibrated radiocarbon years) farming appeared and then spread out from many different regions all over the globe (Price and Feinman 1993):

- In Southwest Asia, agriculture took hold about 10,000 years ago with domestication of grains, goats, sheep, cattle and pigs;
- In Mesoamerica, it happened about 9,000 years ago beginning with the domestication of gourds;
- In South Asia, it occurred about 8,000 years ago with cattle;
- In South America, agriculture appeared about 7,500 years ago with the domestication of gourds, squash and lima beans;
- In East Asia, it happened about 8,000 years ago, this time with the domestication of rice;

- In Africa, it occurred about 7,000 years ago with the domestication of donkeys;
- In North America, domestication appears about 3,200 years ago with sunflower and amaranth cultivation.

Considering the likelihood that anatomically modern humans, that is, *Homo sapiens sapiens*, have been around for at least 100,000 years (based on fossil evidence), the pace of that kind of change is remarkable. To put it in perspective: if we were to make a 100,000 year anatomically modern history equal to one 24 hour period, the transition to agriculture world-wide would have happened very late in the "day" and very swiftly — from about 9:30 to 10:45 PM.

This change that swept the globe did not simply involve a switch from a foraging to a farming diet. It required a paradigm shift that resulted in an unprecedented foundation for the elements of cultural complexity that we see around us today — social inequality, new technologies, standing armies and urbanization, to name a few. Within that one hour and 45 minutes at the end of humanity's metaphorical day, the groundwork was laid for many of the problems and promises that are of interest to human ecologists.

What convinced our hunter-gatherer ancestors to change their survival strategies in so many places in such a relatively small amount of time? Archaeologists and other theorists have spent a lot of energy and ink trying to work this out; proposals run from A to Z. For example, Gitte Gebauer and Doug Price (1992, 2), archaeologists at the University of Wisconsin, have compiled a smörgasbord of causes from a diversity of sources (Table 1). Not all of these possibilities are realistic — for example, archaeologists tend to avoid explanations that implicate space aliens. This inventory is not exhaustive, but it is extensive enough to highlight the diversity of factors, *not one of which* has yet been shown to represent the whole picture.

Table 1. Some causes proposed for the origins of agriculture (from Gebauer and Price 1992, 2).

aliens	natural selection
big men	natural habitat
broad spectrum adaptation	nutritional stress
circumscription	oases
climatic change	plant migration
competition	population growth
desertification	population pressure
diffusion	random genetic kicks
diffusion	resource concentration
domesticability	resource pressure
energetics	rich environments
familiarity	rituals
fat intake	scheduling conflicts
geniuses	sedentism
hormones	storage
intelligence	technological innovation
kitchen gardening	water access
land ownership	xenophobia
marginal environments	zoological diversity

In other words, there seem to be no "prime movers" that work across the board at the global scale; or at least attempts to identify them have failed so far. Perhaps as the database grows and analytical technologies improve, eventually a single factor or set of factors will be sifted out of the pile. However, it seems unlikely. When the scale of analysis is changed to the local level, every region's story is a bit different, involving "homegrown" constraints, factors and forces.

This diversity is not only present in agricultural *invention*. It also characterizes agricultural *adoption* by native hunter-gatherers. For example, consider the transition to agriculture in Denmark, a hot topic in some archaeological circles. To set the stage: by about 4700 bc (uncalibrated radiocarbon years), the farming way of life had a firm foothold in Central Europe. It then spread westward from the former Czechoslovakia, taking no more than 300 years to reach hunter-gatherer societies in what is now Belgium (Price et al. 1995). However, when it got within 1000 km of Denmark it came to an abrupt halt. For some reason, even though this new way of life was waiting out front, it took the local hunter-gatherer population in Denmark at least 500 years to adopt it (Price 1996).

Over the years, people have presented many explanations for this Scandinavian phenomenon, from environmental change to population pressure (e.g., Rowley-Conwy 1985, Larsson 1987). But it wasn't until relatively recently that archaeologists started to seriously consider the idea that the transition may have been an "inside job" (e.g., Jennbert 1985; Price 1996). This hypothesis suggests that, for more than 500 years, hunter-gatherer groups in Denmark developed extensive trade networks with farming groups. They brought in exotic goods that enhanced the status of an emerging, elite segment of society. Over time, their pursuit of power grew to include the adoption of farming itself — a golden opportunity for elite individuals to compete for status by amassing and redistributing agricultural wealth.

The data from which this interpretation has arisen conflict with a common hunter-gatherer stereotype, which prefers small, egalitarian groups of mobile foragers (Kelly 1995). Hunter-gatherers are not supposed to be interested in status and reproducing power; they are supposed to be peaceful, simple people living in harmony with their landscape. Unfortunately, the archaeological record of some regions (Denmark for example) does not agree with this model. In Denmark, the evidence from burials and settlements suggests relatively high populations, sedentism, sophisticated trade networks, even violence (Price 1996) — a lot of the features we associate with complex societies. Thus, it would appear that the aboriginal people in Denmark were part of a complex *hunter-gatherer* society. The natural resources available to them on the coast created a foundation for the emergence of cultural complexity, a phenomenon whose development usually requires an agricultural base.

Ireland offers an alternative, if murkier, view of agricultural transition. Here, between 5500 and 3500 bc (Woodman 1978; Anderson and Johnson 1995), there was a native population of hunter-gatherers — termed the "Later Mesolithic" — who, for all appearances, seem to have maintained a relatively xenophobic lifestyle for about 2,000 years. I use the word "xenophobic" because, unlike the Danish evidence for long-term trade, the uniqueness of Ireland's artifacts — certain kinds of stone tools found nowhere else in Europe (e.g., Figure 1) — hints at a closed society with little or no offshore contacts.

Figure 1. A "butt-trimmed flake," an artifact type unique to Ireland's Later Mesolithic. Photograph of an artifact (ray.01.1/2.4) collected during the Lough Swilly Archaeological Survey and housed in the Donegal County Museum, Letterkenny, Ireland.

The farming transition arguably occurred between 3500 and 3100 bc. From a pollen perspective (archaeologists turn to pollen data when archaeological evidence is absent) the strongest dates for pollen representing the earliest cereal crops in Ireland cluster around 3100 bc (Monk 1993; Edwards and Hirons 1984). Dates associated with Neolithic pottery correspond to those for pollen: Alison Sheridan's (1995, 7) recent efforts to update the ceramic chronology for the Irish Neolithic have led her to argue that "the earliest credible ceramic dates are no earlier than around 3200 bc." Thus, the Neolithic "package" — domesticates (e.g., cereals) and technology (e.g., pottery) — appears to have arrived in Ireland in pieces. While there is very limited evidence for domesticated cattle in a hunter-gatherer context by 3500 bc, it is not until about 3200 bc that a "cultural horizon" (a set of associated archaeological materials identified with a particular culture) appears in Ireland that contains cereals, ceramics and stone tools.

During that time, it would seem that the farmers arrived and the foragers seemingly vanished into thin air. When archaeologists see cultures vanish into thin air, we tend to worry about our sample. Indeed, I must point out that this pattern is observed through a number of filters created by Ireland's geography, climate, and environmental history. As in many other places, sea level change has probably buried or destroyed a large portion of Mesolithic sites; erosion due to shoreline processes and agricultural methods has contributed its share of damage to the archaeological record; alluvial and marine sedimentation also has done its part to obscure traces of Mesolithic settlement; the soils of many regions are acidic, leading to poor preservation of organic remains; and, finally, Ireland's famous blanket and raised bogs cover areas that may have been the focus of significant prehistoric activities (Mitchell 1990). Any of these factors can hinder archaeologists from identifying sites that may contain clues to the nature of cultural change.

However, based on the evidence that we currently possess, some parts of the simple hunter-gatherer stereotype I mentioned above appear to work better in Ireland. Over two field seasons between March and October, 1995, I conducted an archaeological survey in eastern County Donegal, a portion of Ireland's Northwestern territory that had never undergone a systematic investigation of prehistoric settlement patterns (Kimball 1996, 1998). In short, my results mirror an overall pattern for Ireland's Later Mesolithic that is as simple as it is unique by comparison with contemporary Mesolithic cultures elsewhere in Europe. The current sample of Later Mesolithic sites — from Counties Donegal to Cork, Galway to Wicklow — consists entirely of short-term and/or small-scale occupations of aquatically-oriented environments, e.g., the margins of coastal areas, estuaries, rivers and lakes. Exclusively short-term camps suggest a highly mobile lifeway. Small-scale settlements suggest small group sizes, perhaps a single family or extended family. Small hunter-gatherer groups tend to be egalitarian because they do not require the information processing hierarchies that develop among sedentary or aggregated groups (Johnson 1982).

Thus, perhaps the broadest point of distinction between the Danish and Irish cases is that there is no reason to ascribe complexity to the social organization of Ireland's hunter-gatherers. Furthermore, there is no strong evidence for their participation in an inter-cultural exchange network (e.g., with

Neolithic groups in Britain or on the Continent). There is no evidence for sedentism or intensification in resource procurement over time. For approximately 2000 years (from ca. 5500 to 3500 bc) the pattern of Later Mesolithic settlement and subsistence appears to have remained relatively unchanged, until the very end of the period when limited exposure to the agricultural lifeway becomes evident (a few cow bones have been found in one Mesolithic site [Woodman et al. 1997]).

Therefore, in contrast to the Danish situation, the farming lifeway (whether in the form of ideas or people) would not have come up against the structure of a complex hunter-gatherer society when it reached Ireland. Clearly, different mechanisms were involved.

Given this evidence, archaeologists have tended to assume that farming came to Ireland via colonization (Herity and Eogan 1977; Mallory and McNeill 1991; but see Green and Zvelebil 1990 for a contrary perspective). Farming groups in Britain or the Continent loaded their families, livestock and belongings into boats and paddled to Ireland. This explanation fits the data reasonably well, but it does not tell us what happened to the natives. At this point, there are not enough data to address this problem. What decisions and processes lay behind the adoption of agriculture by Ireland's native people?

In summary, explaining agricultural adoption or invention obviously requires that one concentrate on the local level. Yet, the fact remains that over the course of only 5,000 years — just a drop in humanity's bucket — all these local developments came together to produce a global eruption of cultural change. How does such a coherent global pattern emerge from such local diversity? We may need new models — perhaps a new paradigm — to answer this question.

Complexity and Perplexity in the Analysis of Cultural Change

Recently, the science of complexity has provided a fresh perspective on this problem. The Santa Fe Institute (or SFI) in New Mexico is a well known breeding ground for complexity research (Waldrop 1992; Cowan et al. 1994). Interdisciplinary SFI teams are working on some exciting projects that seek to model the processes that produce global patterning from local-level interactions. Given a simple set of rules for how to interact with their neighbors, computerized "agents" are turned loose in a virtual world. Global patterns of organized behavior emerge from their interactions, leading to the formation of virtual insect swarms and ecosystems. Complex phenomena — economies, biological evolution, ant colonies — appear at a statistical "edge of chaos," i.e., a place somewhere between the monotony of order and the randomness of chaos. The important point of emphasis here is that simple phenomena occurring at a high level — e.g., the spread of agriculture across the globe over a relatively short period of time — spontaneously develop from complex phenomena occurring at a lower level — e.g., the myriad of decisions made by people engaged in one-on-one interactions.

A subset of SFI researchers is interested in working on patterns of stability and change in cultural systems. In a recent issue of the SFI Bulletin (1998), several projects are mentioned. Teams are modeling prehistoric settlement pattern change in northeastern Arizona as a response to environmental variables; adaptive choices by households in southwest Colorado between AD 900 and 1300; the relationship between group-level foraging decisions and local-level interactions within primate societies; and the emergence of plant domestication among early Holocene foragers in central Oaxaca in southern Mexico.

However, SFI's modeling efforts concentrate primarily on mimicry. In other words, their simulations mimic the patterns we see in nature; they do not explain them. It comes down to the same problem of analogy vs. homology that arises in evolutionary biology: are the observed patterns similar only in appearance or do they actually share the same origins? George Cowan, a co-founder of SFI, has referred to this problem as the "reminiscence syndrome" (in Horgan 1995, 107). In other words, computer simulations that are merely reminiscent of natural phenomena are tacitly assumed to be *models* of those phenomena.

The complexity of human society offers an even greater challenge. Human decisions are full of strange motivations and inconsistencies. Even though SFI certainly has the human ingenuity to tackle this problem, it still has difficulty moving from the metaphors provided by simulations to the problems presented by real life. Part of the solution undoubtedly lies in computational power; however, another part lies in our understanding of human behavior.

Sufficient computational power may be around the corner. In the September 2, 1997, edition of the New York Times' "CyberTimes" section, George Johnson reported on Janus, a supercomputer that can perform a trillion mathematical operations per second. It is called a "teraflop" computer, which is shorthand for a trillion floating point operations or "flops." Analysts predict the arrival of a petaflop computer — boasting a quadrillion operations per second — in less than 15 years. Some believe it is only a matter of time before the gap between the virtual (simulated) world and the real (empirical) world is finally bridged.

However, this word "flop" is perhaps most appropriate when characterizing powerful simulations that are run without sufficient understanding of the cultural systems they are supposed to model. Models are based on assumptions that should be explicit and informed by real-world observations. Regardless of our arguable potential to bridge the gap between the worlds, the challenge — and fun — for human ecologists and archaeologists alike lies at the local level, where people make their peculiar decisions; where, to paraphrase the poet, we can pry into roots, finger slime and set the darkness echoing.

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Endnotes

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