CHAPTER 1

INTRODUCTION

> What we observe is not nature itself, but nature exposed to our method of questioning.
>
> Werner Heisenberg (1958) *Physics and Philosophy: The Revolution in Modern Science*

This is a book about questions. Many archaeological books and scientific papers ask what stone tools can tell us about human evolution. Others ask what the evidence for human evolution can tell us about stone tools. These are both good questions, but they each suffer the same weakness. They want to use the inferred qualities of one unknown thing to explain the inferred qualities of another unknown thing. This book asks different kinds of questions. It asks how something we can observe today explains something else we can observe today. Specifically, it asks how behavioral differences between humans and other primates explain changes in the archaeological stone tool evidence. This is a very different sort of question from the ones archaeologists have been asking, and unsuccessfully trying to answer, with the stone tool evidence. This chapter argues that many of the archaeologists' difficulties connecting the stone tool evidence to major issues in human evolution stem from asking the wrong questions and from inappropriately projecting qualities of recent human tool use back into remote antiquity.

LITTLE QUESTIONS VS. BIG QUESTIONS

For the last three million years hominins (bipedal primates) littered the Earth with stone tools. This lithic evidence adds richness and detail to our understanding of human evolution beyond what fossils and genes alone can tell us. Fossils are rare and fragile, and genes speak mainly about ancestry. Stone tools are common, nearly indestructible, and preserved no matter what their authors'

evolutionary fates. To understand stone tools' place in human evolution, we have to ask "big" questions, questions central to human origins research. All too often, archaeologists ask "little" quasi-historical questions, such as who made which sets of lithic artifacts and how prehistoric tool makers were related to one another culturally. There is nothing objectively wrong with such little questions. Properly investigated, they are worthy of attention. Culture history is no less a part of our evolutionary heritage than our opposable thumb is. But, culture history questions are not "big" questions. Archaeologists are the only people who ask such questions, and few people other than archaeologists care about the answers to them. By focusing so much of our energies on culture historical questions, archaeologists neglect more evolutionarily important and anthropologically interesting issues (Shea 2011c).

Anthropology's two big questions are (1) how are humans different from other animals and (2) why do humans differ from one another? Everything anthropologists do is ultimately in the service of those two questions. Paleoanthropology investigates the origins of these differences, and the stone tool evidence is directly relevant to both of them. Humans and non-human primates differ in the extent to which we make and use stone tools, how we use them, and in the kinds of tools we make. The most adept non-human primate tool users are our nearest living non-human relatives, chimpanzees (*Pan troglodytes*) and bonobos (*P. paniscus*). Behavioral differences between humans and these apes are obvious starting points for research on behavioral variation among "technological primates." All humans were stone tool users until a few thousand years ago – yesterday on an evolutionary timescale. If there are deep and transcendent principles governing human cultural and behavioral variability, they ought to be discoverable in the stone tool evidence.

Stone Tools in Human Evolution investigates the lithic evidence for the evolution of behavioral differences between humans and non-human primates in comparative, analytical, and strategic perspectives. The behavioral differences on which it focuses include the following:

- Cutting tools (Chapter 4): Non-human primates use stone tools as percussors. Humans also use stone tools to cut, pierce, and divide things.
- Logistical mobility (Chapter 5): Non-human primates bring consumers (themselves) to resources. Humans also transport resources to consumers.
- Language and symbolic artifacts (Chapter 6): Non-human primates communicate by gestures and vocalizations. Humans also use language and symbolic artifacts.
- Dispersal and diaspora (Chapter 7): Non-human primates live in the tropics and warmer temperate latitudes. Humans live in a global diaspora.
- Residential sedentism (Chapter 8): Non-human primates move daily. Humans reside in the same places for periods ranging from days to their entire lives.

Chapters 4–8 evaluate how these differences affect human and non-human primate stone tool use today, and they predict how the stone tool evidence should have changed as the distinctively human behavior pattern evolved. Each chapter tests these predictions by examining lithic assemblages from the period when fossil, genetic, and other non-lithic evidence suggest the characteristically human behavior appeared. These are not the only important behavioral differences between humans and non-human primates, but they are enough to show a new path to better integrating the stone tool evidence into human origins research.

To test predictions about changes in the stone tool evidence, this book employs data from lithic assemblages dating from around 6000 years ago (6 Ka, Ka = × 1000 years) to more than 3,000,000 years ago (3 Ma, Ma = × 1,000,000 years). In selecting these assemblages, I chose ones from sites generally viewed as representative of the evidence from given regions and time periods. I assessed their representativeness from their being named in recent published syntheses of particular time periods and from correspondence with colleagues. I winnowed a list of several hundred assemblages to a manageable 250 by applying four further selection criteria. Assemblages had to have been published in peer-reviewed books or journals and in languages in which I am fluent (English, French, and German). Their archaeological contexts had to be reasonably well dated, and their descriptions of the lithic evidence sufficiently detailed to allow me to reorganize it in the framework this book uses for describing variation in how stone tools were made. Some less-well-known assemblages were selected in order to achieve a degree of geographic representativeness. No assemblages were added after the fact to alter the results of any statistical tests or to support predictions that were previously unsupported.

This book differs from previous books about stone tools and human evolution in several important ways.

First, *Stone Tools in Human Evolution* does not try to tell a story about human evolution. Stories, or "narrative explanations," are cultural universals as old as history itself, and probably much, much older. Early paleoanthropologists expressed their hypotheses about human evolution in narrative frameworks, and the practice continues to this day (Landau 1991). Narratives force one to arrange complex evolutionary processes into simple linear chains of cause and effect. All evolutionary narratives of human origins begin with the oldest evidence, evidence about which geological attrition alone guarantees we know the least. Interpretive errors made at the beginning of such a narrative make all subsequent interpretations in that narrative wrong too. Narrative explanations for events that took place over geological/evolutionary timescales are intrinsically likely to be wrong.

Second, *Stone Tools in Human Evolution* does not speculate on evolutionary relationships among the various hominins associated with stone tools. This book does not reject hypotheses that evolutionary divergences among

hominins influenced the stone tool evidence (Foley 1987, Mithen 1996), but neither does it invoke evolutionary relationships to explain the variation in the lithic record. Instead, it seeks explanations for prehistoric lithic variation in terms of behaviors whose influences on stone tool production and use can be empirically verified by ethnography, ethology, and experimentation.

Third, *Stone Tools in Human Evolution* speculates minimally about how cognitive changes in hominin evolution might have influenced lithic variation. There are almost certainly important linkages between human cognitive evolution and change/variability in the stone tool evidence. However, "cognitive archaeology" today offers divergent views about the nature of these changes (Mithen 1996, Stout et al. 2015). As with phylogeny, there are so many competing hypotheses about changes in hominin cognition that discussing all or even a fraction of them would overshadow those parts of the book devoted to less controversial behavioral differences between humans and non-human primates.

Fourth, *Stone Tools in Human Evolution* is neither a technical manual about how to analyze lithic artifacts from archaeological sites nor a guide to how to make and use stone tools (for such works, see Whittaker 1994, Inizan et al. 1999, Odell 2004, Andrefsky 2005, Patten 2009, Shea 2015a). It is intended as a "course book," a book to accompany the main text for college-level courses in human evolution. While I hope archaeologists will find it interesting, it is really addressed more to biological anthropologists who are skeptical about stone tools' value in human origins research.

Finally, as noted in the Preface, *Stone Tools in Human Evolution* does not use many traditional archaeological terms for time periods, stone tool industries, or artifact-types. The evolution of behavioral differences between humans and non-human primates was not a part of nineteenth- and early twentieth-century archaeologists' research agendas. We should not expect their ways of organizing the archaeological lithic record to be helpful in investigating this subject. Late nineteenth- and early twentieth-century archaeologists devised these terms and concepts as aids to sorting stone tool assemblages in time, or "chronostratigraphy" (e.g., de Mortillet 1883). Decades later, other archaeologists repurposed them, largely unmodified, as aids to writing Stone Age "culture history" (e.g., Bordes 1968). It is not impossible that these artifact-types might work well in their new purposes; but, this is something archaeologists *hope* to be true, not something they *know* to be true (Shea 2014). Much of the progress archaeologists have made in understanding the lithic evidence for Pleistocene hominin behavioral variability they have accomplished in spite of these traditional ways of describing the stone tool evidence, rather than by recourse to them (e.g., Binford 1983, Potts 1988, Boëda, Geneste, and Meignen 1990, Rolland and Dibble 1990, Kuhn 1993, Shea 2010; for a recent review, see McCall 2014).

We need terms to describe stone tool production and stone tools themselves. For this purpose Chapter 3 introduces Modes A–I. Modes A–I is a framework

based on observed tool making behaviors among humans and non-human primates (Shea 2013a). Using Modes A–I allows simple and straightforward comparisons of evidence from different regions and time periods. To explain why this book requires a break with traditional archaeological approaches to the lithic record, the next section discusses how archaeologists' difficulties with stone tools arose in the first place.

WHY ARCHAEOLOGISTS MISUNDERSTAND STONE TOOLS

What would one make of an artifact of extraterrestrial origin? If it was made of metal, one could confidently infer those who made it controlled heat, but hypotheses based on analogies with our own technologies would be more risky. If it was elongated and pointed at one end, one might conclude that it was a weapon. But might it not be an art object or a telecommunications device? (The 1951 science fiction film *The Day the Earth Stood Still* showed such uncertainty leading to near-disastrous "first contact" with an extraterrestrial emissary.) We humans share far more evolutionary history with earlier hominins than we would with an extraterrestrial; so, our surmises about prehistoric stone tools ought not be as wide of the mark as those involving alien technology. Nevertheless, many misunderstandings about stone tools arose and persist because early archaeologists interpreted prehistoric lithic artifacts through the lens of familiar technology.

European archaeologists recognized stone tools as prehistoric artifacts in the late eighteenth and early nineteenth centuries (Grayson 1986). Like geologists and paleontologists, early archaeologists interpreted these artifacts using principles derived from observing the world in which they lived. Early archaeologists lived in industrial states, and their hypotheses about prehistoric stone tools reflected analogies with Industrial Era technology. "Flintknapper" or "knapper," terms now used for stone tool producers in general, originally referred to craft specialists who mass-produced gunflints (Skertchly 1879). The names archaeologists gave to stone tools, such as burin (French for chisel), pick, and scraper, were originally terms for metal implements. Archaeologists thought prehistoric lithic technology was organized as a simple linear process, much like that involved in the mass-production of nails, pottery, or gunflints. Raw materials were gathered from "quarries" and transported in bulk to "factory sites" where craftsmen shaped "finished artifacts" that were dispersed to consumers (Clarke 1935) (Figure 1.1). They envisioned chronologically sequential changes among stone tools as substitutions in much the same way that technological change occurs in industrial societies, with older and obsolete technologies replaced by "new and improved" ones (e.g., horse-drawn carriages by automobiles, whale oil candles by electric lights).

The mismatch between this "Industrial Model" and how pre-industrial and non-industrial societies made and used stone tools is increasingly obvious.

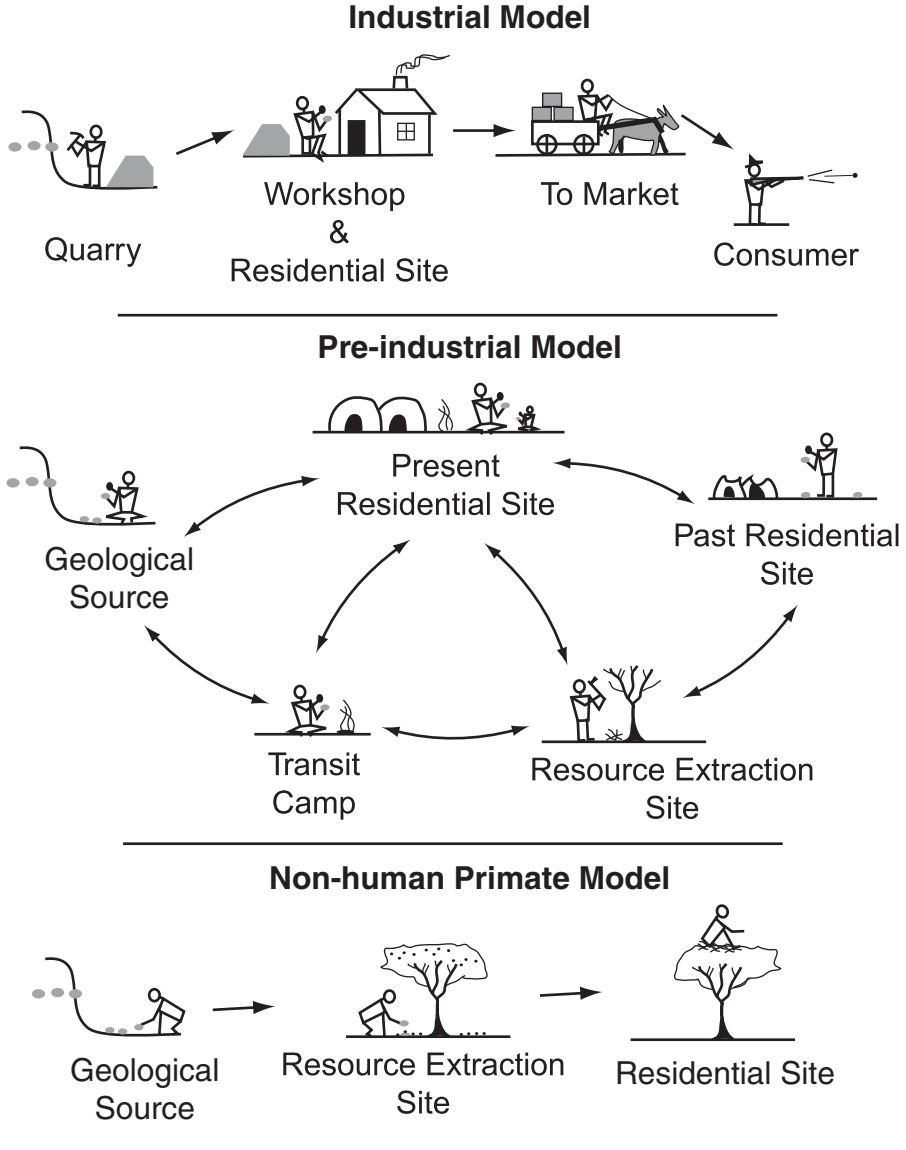

Figure 1.1 Industrial vs. pre-industrial and non-human primate models of stone tool production. Industrial Era flintknapping (above) was a linear process in which raw material procurement, tool production, use, and discard occurred separately from one another. Pre-industrial stone tool production by mobile populations was complex and non-linear (below). Raw material procurement, tool production, use, and discard could occur separately or commingled with one another. Non-human primate stone tool use is also a linear process in which tool materials are moved from places where they occur to places where they are needed.

Pre-industrial societies organized stone tool production, use, and discard as non-linear networks dispersed across landscapes (e.g., Gould 1980, Holdaway and Douglas 2012). These networks were especially complex among hunter-gatherer populations who frequently relocated their habitation sites, groups

with high "residential mobility." Among such residentially mobile humans, relationships between artifact designs, stone tool functions, and cultural identities were complex and contingent over time and space. Multiple lines of evidence suggest earlier hominins were at least as residentially mobile as recent human hunter-gatherers, if not even more so. It follows that we should expect similar, if not even greater, qualities of technological and functional variability in those hominins' lithic archaeological record.

Humans are not the only stone-tool-using primates. Field studies and experimental research show that our nearest living non-human primate relatives, chimpanzees and bonobos, exhibit a wide range of stone-tool-using activities. Archaeological investigations of non-human primate tool use, or "primate archaeology" (or, more precisely, archaeological primatology) are increasingly popular (Haslam et al. 2009). These studies enrich our understanding of human evolution, but one must use them cautiously.

First, living non-human primates are not ancestral hominins. That chimpanzees crack open nuts with stone tools does not mean earlier hominins did so, too.

Second, descriptions of non-human primate tools borrow terms in common usage for human tools, such as "hammerstones," "anvils," and "spears." All tools used by non-human primates are morphologically, measurably, and functionally distinct from tools made and used by humans.

Finally, reports of non-human tool use tend to emphasize similarities with human behavior. Similarities can be interesting, but they may reflect common ancestry, convergent evolution, or simply perceived analogies. In evolution, differences are more important than similarities.

Earlier hominin stone tool use was probably not identical either to non-human primate stone tool use or to ethnographic stone tool use. Wild-living primates do not make stone cutting tools like those found in prehistoric archaeological sites. Complex patterned variation like that seen among ethnographic stone tools graces only the latest phases of prehistory. Prehistoric hominin stone tool use likely combined evolutionarily "primitive" (i.e., ancestral) behaviors as well as "derived" (newly evolved) ones. Determining which combinations of such ancestral and derived behaviors were in place at any given point in human evolution requires us to explore the reasons why there are differences between human and non-human primate stone tool use. If we can determine why, for example, humans do something with stone tools while other primates do not, such as attaching stone tools to handles ("hafting"), then we can make predictions and test hypotheses about where and when in prehistory we should find evidence for hafting. Admittedly, hafting might have originated in activities no longer undertaken by living humans, but our hypotheses have to come from somewhere, and the best such sources are those we can observe directly.

The merits of a comparative analytical approach seem so obvious they beg the question of why early archaeologists did not use studies of living

stone-tool-using peoples and non-human primates as sources of hypotheses about prehistoric stone tool use. Some nineteenth- and early twentieth-century archaeologists actually did look to the ethnographic evidence for inspiration, but they had limited resources at their disposal (Lubbock 1865). Museum collections housed artifacts gathered by explorers and colonial officials, but few of these artifacts were accompanied by detailed information about how they were made and used. A few gunflint knappers still practiced their craft in Europe, but traveling to observe stone tool production and use in non-industrial settings was dangerous and difficult. During the late nineteenth and early twentieth centuries, stone tools were still being made and used in Africa, Asia, Australia, New Guinea, the Pacific Islands, and in the Americas. At the time, however, indigenous populations in many of these regions were struggling against European and American colonial powers. A visiting archaeologist seeking stone tool makers stood a good chance of being killed in the process. Some early ethnographers (cultural anthropologists) encountered stone-tool-using people, but few made detailed studies of this fast-vanishing technology. Anthropologists of that era were mainly interested in recording languages, kinship systems, and other phenomena that they thought predicted variation in human behavior. Few ethnographers had much professional training in archaeology or experience describing lithic technology.

Most ethnographic accounts of stone tool production and use were written by explorers, missionaries, and colonial administrators, but only rarely by anthropologists or archaeologists. Some of these accounts are good and remain useful, but nearly all of them are "normative." That is, they focus on "typical" patterns of stone tool production and use, on central tendencies and modalities, rather than on other dimensions of variation and sources of variability. Such normative descriptions of lithic evidence were not unique to ethnography. Most terms archaeologists used to describe prehistoric stone tool evidence were normative ones, too (Taylor 1948, Binford 1962), and they remain so to this day (Clark and Riel-Salvatore 2006). During the 1970s archaeologists began undertaking "ethnoarchaeological" studies of recent human material culture and site formation processes, but by this point in time few ethnographic groups were still habitually making and using stone tools. Ironically, ethnographic lithic technology declined just as "craft/hobby flintknapping" began to grow in North America and Europe (Whittaker and Stafford 1999).

Early archaeologists did not draw on studies of non-human primate stone tool use as models for earlier hominin behavior largely because they were unaware non-human primates used stone tools. Experiments with captive chimpanzees had shown that they could be taught to use tools and that they could solve problems with tools creatively (Köhler 1925). However, traveling to African apes' equatorial habitats during the late nineteenth and early twentieth centuries was even more dangerous than visits to ethnographic stone-tool-using humans.

Primatologists only reported tool use by wild-living non-human primates in the 1960s and stone tool use more recently than that. Most detailed studies of chimpanzee and other non-human primate tool use have only been published in the last several decades (McGrew 1992, Boesch-Aschermann and Boesch 1994, Haslam et al. 2009).

We still do not know as much as we might wish about pre-industrial human and non-human primate stone tool use. But, as Chapter 2 shows, we can use what we know to construct a more realistic alternative to the Industrial Model of lithic technology, a "Pre-Industrial Model" from which we can deduce testable predictions about prehistoric stone tool production and use.