Paleolithic

AARON JONAS STUTZ
Emory University, USA

Introduction

Paleolithic era means "old stone age." It was originally defined by John Lubbock ([1865] 1872), who juxtaposed the term against the late prehistoric *Neolithic era*. Before the metal ages, he proposed, there were two ages of stone, namely:

> I. That of the Drift; when man shared the possession of Europe with the Mammoth, the Cave bear, the Woolly-haired rhinoceros, and other extinct animals. This we may call the "Palaeolithic" period.
> II. The later or polished Stone Age; a period characterized by beautiful weapons and instruments made of flint and other kinds of stone; in which, however, we find no trace of the knowledge of any metal, excepting gold, which seems to have been sometimes used for ornaments. This we may call the "Neolithic" period. (Lubbock [1865] 1872: 2–3)

Lubbock not only proposed subdividing the Stone Age into an "old" and a "new" part, thus building on Christian Jürgensen Thomsen's now classic presentation of Danish archaeological evidence for a tripartite, raw material-based sequence of prehistoric ages (namely Stone, Bronze, and Iron); he also presented a long argument for situating the Old Stone Age in the broader context of the Earth's natural history. He was a key figure during a critical period of Victorian scientific work. In the years after Charles Darwin (see DARWIN, CHARLES R.) published *On the Origin of Species* (1859), substantial effort was made to synthesize archaeological, paleontological, and geomorphological evidence for the antiquity of human origins and for the natural process of population change throughout human evolutionary emergence and adaptation (Daniel 1962; Grayson 1983).

Today, at least partially reflecting the Eurocentric focus of early modern archaeological inquiry, the Paleolithic–Neolithic framework continues to be employed in Europe and adjacent continental and subcontinental areas, primarily in Asia and North Africa (Shea 2017). Researchers in other regions have often found the Old–New Stone Age framework to be too simple—or entirely irrelevant. This entry addresses the Paleolithic time frame. It describes the period's onset, the commonly employed chronological subdivisions, and the challenges to defining its terminus. It also introduces theoretical issues concerning Paleolithic subdivisions and the Paleolithic–Neolithic division. It concludes by summarizing some key conceptual approaches to describing technological evolution in the Stone Age.

The Paleolithic's onset

The Paleolithic era's beginnings have a straightforward definition. They are marked by the oldest known stone tools. At the Lomekwi site, Kenya, ca. 3.3 Ma, lithic artifacts include large flakes, which were detached from basalt cobbles and blocks, using a hammer-and-anvil—that is, bipolar percussion—technique (Harmand et al. 2015). The chronological and geographic setting suggests that australopithecine populations were the bearers of this oldest stone tool cultural tradition documented for the hominin lineage (see AUSTRALOPITHECINE/AUSTRALOPITH). Among our extant ape relatives, multiple chimpanzee (*Pan troglodytes*) communities have been observed to use—and culturally, intergenerationally transmit—hammer-and-anvil technology to crack nuts (see TOOL USE IN APES AND MONKEYS). In the wild, neither chimpanzees nor bonobos (*Pan paniscus*) have been observed to modify stones in order to obtain cutting or scraping edges. Thus, stone tool *making* appears to be a unique-derived hominin behavioral trait, absent among panins (Shea 2017). At Lomekwi, Harmand and colleagues (2015) suggest, hominins

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could have detached sharp flakes with the same equipment they might have used to crack or pound a variety of omnivorous food resources, from animal bones to nuts, seeds, and starchy roots and stalks. The fossil hominin species best documented at 3.3 Ma in East Africa is *Australopithecus afarensis*, hand bones from which suggest some precision grasping functions (see HANDS (PRIMATE)). *Au. afarensis*' manual anatomy would have supported wielding a heavy-duty hammer stone in one hand, while the other hand positioned the core on an anvil. The *Au. afarensis* hand bones from the Hadar AL-333 locality in Ethiopia (also ca. 3.3 Ma) suggest relatively effective thumb-on-finger, pad-to-pad manual grasping of the resulting sharp flakes, adaptive for more frequent or habitual cutting and scraping (see Barham and Mitchell 2008).

A gap exists in the earliest Paleolithic archaeological record until 2.5–2.6 Ma. Several East African sites—most notably those around the Gona locality, Ethiopia—date from this time, yielding archaeological associations of cores, flakes, and hammerstones. At Gona some sites also incorporate animal bones with stone tool cut marks. The cores and flakes are consistent with in-hand hammer-on-core percussion. This basic *knapping* technology is thought to require a stronger precision grip, involving shorter manual digits, broader fingertips, and a long and broad, powerfully opposable thumb. It also presupposes more detailed learning. The twofold goal consists of *sustaining selective attention* on the hand-to-hand activity itself, along with *making rapid, sequential sensorimotor judgments in carrying out the learned, embodied action habits* for striking the core at a precise spot and proper angle. The result is the reliable production of a fracture that releases a thin, very sharp flake. In contrast with the "Lomekwian" hammer-on-anvil technique for flake production, hammer-on-core percussion results in less waste and, thus, more total cutting edge. The in-hand hammer-on-core percussion technique also potentially yields useful core choppers. This constitutes the Oldowan industry, first defined by Louis Leakey (see LEAKEY, L. S. B.) in his investigations of Beds I and II at the base of the Olduvai Gorge (see OLDUVAI GORGE) sequence, Tanzania (ca. 2.0–1.5 Ma) (Klein 1999; Barham and Mitchell 2008). It is unclear whether the makers of the earliest Oldowan stone tools were from australopithecine populations or early members of the genus *Homo*. Regardless, current evidence provides not only a time, but also a region—East Africa—for the earliest onset of the Paleolithic era. Indeed, well-dated sites with Oldowan chipped stone assemblages are no earlier than ca. 1.8 Ma in South Africa and western Asia. It appears that, as human populations grew and dispersed with stone tool-making traditions, the Paleolithic era was essentially established at somewhat different times in different regions. Table 1 defines some general terms used in Paleolithic research. Table 2 summarizes the geological context, chronological span and period subdivisions, and technological *industry* names that have become standard for describing Paleolithic sequences in a sample of regions in Africa and Eurasia.

Empirical challenges to defining chronological subdivisions of the Paleolithic era

The Paleolithic era encompasses more than 3 million years of hominin prehistory. It covers the emergence of human hunting and gathering (see HUMAN UNIQUENESS). The evolution of technologically dependent, cooperative omnivorous foraging eventually shaped the late Quaternary biocultural conditions in which post-Paleolithic adaptations—agriculture, food storage, and village life—were favored. Considering the vast chronological scope of the Paleolithic era, it is not surprising that researchers have sought to divide it into major periods. The Paleolithic periods usually follow a tripartite scheme: Lower, Middle, and Upper. Transitional or terminal periods—for example, Epipaleolithic or Mesolithic—have often been added in regional prehistoric sequence frameworks (see Table 2).

The tripartite division of the Paleolithic was initially developed in European research (Bordes 1968). It has proved resilient as a terminological scheme. Researchers still use it for describing major technological transitions and developments more widely, in Western Eurasia and in much of northern Central Asia. The criteria

Table 1 Key Paleolithic terminology, with a focus on stone technology.

Term	*Definition*
Core	rock with concave flake-release scar(s), where the flakes are removed through fracture, from one or more striking locations
Flake	thin stone fragment detached from a core by controlled fracture; also used as a verb, denoting the controlled-fracture removal of a flake from a core
Raw material	rock from which stone tools are made; those shaped by fracture are mostly silicates such as flint/chert, obsidian, or quartz, but also non-silicates such as basalt
Percussion	forceful striking of a core or other stone artifact, in order to create a fracture
Hammerstone	a rock, usually rounded, used to create a fracture in a stone tool
Knapping	originally used to describe the work of historical gunflint manufacturers; now widely used to describe controlled-fracture stone tool production
Large cutting tool (LCT)	a term used to describe *bifacially* flaked cores, which become relatively thin through flaking—with slight to moderate convexity on both faces—but also elongated on one axis; examples include hand-axes and cleavers; Shea (2017) renames LCTs "long core-tools", noting that cores with such morphology were not used just for cutting (or even necessarily used as tools)
Blade	elongated flake with parallel lateral edges, whose length is at least twice its width; a *prismatic blade* has proximal–distal-oriented parallel *flake scars* on its dorsal surface, revealing recurrent blade removal from the same or opposed striking platforms on the core
Bladelet	a blade < 50 mm in length; bladelet production is usually important in later Paleolithic microlithic technologies
Retouch	small continuous fractures along a tool edge caused by pressure or percussion
Microwear	small-scale fracturing, striations (scratches), and polish resulting from use and postdepositional forces
Levallois technique	hierarchical strategy for reducing the core: larger flakes are detached, singly or sequentially, from a surface that has been pre-shaped through smaller flake removals from its margins. The Levallois technique is known from Middle–Late Pleistocene contexts, ca. 800–20 kya, in different regions across Africa and Eurasia
Operational sequence (Chaîne operatoire)	behaviorally, it is a learned sequence of gestures involved in a pattern of technological production; operational sequences in stone tool production convey social information while also reflecting economic activities and trade-offs in any society's larger behavioral and ecological context
"Symbolic" artifacts	artifacts that would have been primarily decorative or *mediated* decorating the body and its surroundings; examples include shell and tooth beads, engraved objects, shell pigment mixture containers, and figurative sculptures
Lithic assemblage	stone artifacts from the same archaeological context or geological deposit
Industry	a set of common manufacturing techniques and tool types shared among a group of assemblages, usually from a particular region and time period
Technocomplex	a set of common manufacturing techniques from assemblages in which variable tool types may be represented

Definitions are mainly based on Shea (2017: 198–204).

Table 2 Chronology of the Stone Age, including Paleolithic and Neolithic schemes in select regions of Africa and Eurasia. Age is shown in thousands of years (ka) in *logarithmic* scale.

Age (kya)	*Sub - Saharan East Africa*	*Europe*	*Mediterranean Levant*	*East Asia*	*Geological Epochs*	
0					Holocene	Quaternary
	Iron Age					
	Agriculture & Animal Husbandry	Neolithic ↑ Mesolithic	Pottery Neolithic	spread of Neolithic technologies		
			Prepottery Neolithic			
10 ca. 11–12	Late Stone Age		Epipaleolithic	spread of Upper Paleolithic technologies		
		Upper Paleolithic	Upper Paleolithic			
ca.45–40		Middle Paleolithic	Middle Paleolithic		Late Pleistocene	
100	Middle Stone Age			mainly Lower Paleolithic - like technologies (core and flake; long core tool; pebble tool technologies)		
ca. 300–250		Lower Paleolithic	Lower Paleolithic		Middle Pleistocene	
1,000	Early Stone Age				Early Pleistocene	
2,000					Late Pliocene	Tertiary ↓
3,000	Lomekwian					

separating Lower, Middle, and Upper Paleolithic periods are highly archaeologically visible ones, having to do with the presence or absence of technological or formal, typological features identified in many *lithic assemblages*, from many sites. Thus the Lower Paleolithic period is mainly associated with in-hand and bipolar flake production, often alongside bifacial *long core tool* production. The Middle Paleolithic period often involves a proliferation of *retouched* flake tools—mainly sidescrapers on flakes—but it also includes prepared-core techniques (most commonly, the Levallois technique) for controlling flake shape and thickness. The Upper Paleolithic period is marked by the spread of blade and bladelet production, along with the diversification of retouched tools, such as burins and end scrapers. Tools made of bone and antler, along with decorative objects made of/on bone, teeth, shell, and stone slabs, are much more common in the Upper Paleolithic period, although their diversity and abundance vary greatly by region and subperiod.

Innovations in stone tool technology—as important as they would have been for biocultural adaptations in the Paleolithic era—were not always adopted in the same simple cumulative sequence. Nor did they necessarily co-occur with major biological changes in anatomy. They were not necessarily linked to particular Plio-Pleistocene climatic swings or demographic shifts either (including population range expansions or regional abandonment episodes). The mosaic of technological, social, demographic, and biological change in one region usually differed—sometimes subtly, sometimes dramatically—from biocultural change in neighboring areas. For example, Oldowan-like core-in-hand flake production persisted in many parts of eastern Asia throughout much of Late Pleistocene. In other words, across a large portion of the Asian continent, Paleolithic terminology per se does not add clarity to important developments in biocultural evolution (Bar-Yosef 2015).

In order to address the lack of a universal chronology of Paleolithic technological change, Grahame Clark proposed a series of fundamental modes of stone tool production (Clark 1969). The five modes that Clark suggested are numbered in order of first appearance in the Paleolithic era. These are (1) pebble core and flake technology (exemplified by Oldowan industries); (2) large bifacial cutting tool technology (including handaxes and cleavers); (3) prepared-core technologies such as Levallois flake, point, and blade production; (4) prismatic blade and bladelet production (which emphasizes blade production using indirect punch techniques); and (5) production of retouched microlithic points and cutting edges on bladelets and flakes (which yields pieces inserted into compound projectile or cutting tools) (Figure 1). In general, after first appearance, a given mode may disappear in a given region, only to be adopted or independently invented again, much later. As the Chinese and Australian cases exemplify—with Mode 1 technologies employed by some anatomically modern human populations after 50,000 years ago—the organizational complexity or technical intricacy of making stone tools may have nothing to do with the derived human capacity for linguistic communication or social network

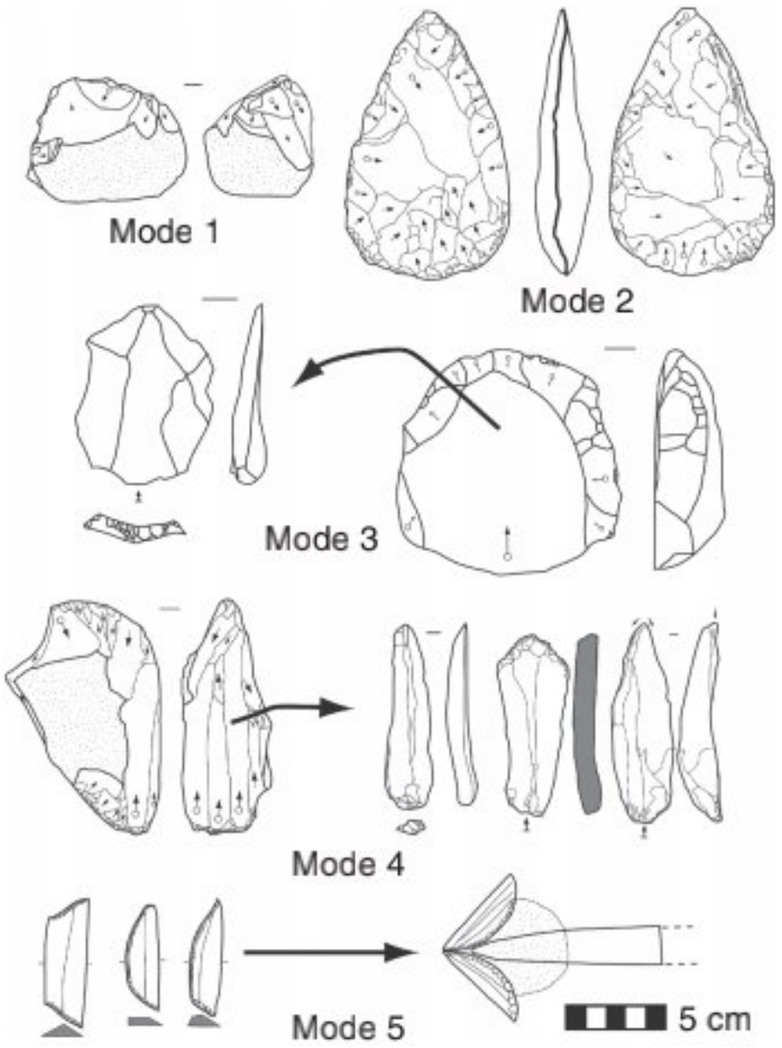

Figure 1 Grahame Clark's model of technological development and diversification in the Paleolithic era: modes 1–5.
Original artwork by John J. Shea, reproduced with his permission.

formation (Bar-Yosef 2015; Lourandos 1997). Acknowledging the general descriptive value of the five modes, Shea (2013) has highlighted some inconsistent or vague definitions in Clark's model. In doing so, Shea (2013, 2017) has proposed a clarification and expansion of Clark's list to nine Paleolithic stone tool production modes, in order to recognize the full range of techniques used—at different times and places—in the Stone Age.

Theoretical and empirical challenges to defining the end of the Paleolithic

First appearance provides a simple criterion for documenting Paleolithic onset in different regions. As emphasized above, there are no clear, universal hallmarks that allow comparable subdivisions of the Old Stone Age in all regions. Archaeologically visible technology—especially chipped stone technology—changed in different ways, at different rates, from one region to the next. The problem of defining the Paleolithic's terminus further sheds light on the complexity of hominin biocultural evolution. In a given population and ecological setting, technological change often involved gradual change in some features and rapid, well-defined transitions in others (Kuhn 2013).

Lubbock's criteria for what the Paleolithic lacked and the Neolithic had—that is, polished or ground stone technologies, resulting in "beautiful weapons and instruments made of … stone"—arguably offer more insight into his limited observation set, which he further considered through the lens of a Victorian ideology of fundamentally valuing economic, aesthetic, and moral progress—an ideology framed as an escape from primitive, prehistoric poverty (see Lubbock [1865] 1872, ch. 16). In fact, as he was writing the first edition of *Pre-Historic Times*, Lartet and Christy were exploring the rock-shelter of la Madeleine in southwestern France. Excavating layers with flint bladelets and other chipped stone tools, they uncovered a woolly mammoth ivory artifact with the figure of a mammoth engraved on it. At many other sites in France and Belgium, archaeologists had already begun to document shell and bone beads, along with bone and stone engraved objects, all stratigraphically associated with later Paleolithic—but certainly Paleolithic—stone tools and extinct mammal bones (Grayson 1983). In other words, Neolithic-like artifacts that were considered more "refined"—or that, more objectively, involved grinding, polishing, engraving, or drilling technologies—actually were made well within the Old Stone Age. The transition between the two eras was hardly abrupt or catastrophic.

More recent research has confirmed this relatively gradual aspect of technological evolution, revealing shells and red ochre with geometric engravings as old as 500–100 kya. These finds come from places as disparate as Java, Indonesia, and coastal South Africa (Henshilwood, d'Errico, and Watts 2009; Joordens et al. 2014). The proliferation and long-term sociobehavioral modification of technological media, practices, and products—which comprise a key aspect of humanity's joint biological and cultural adaptations and niche—are well documented archaeologically. Indeed, it appears that the diversification of technological systems accelerated in more recent Stone Age periods, ca. 200–10 kya (McBrearty and Brooks 2000).

The gradual emergence of technological complexity and variation—with local prehistoric sequences that show millennial-scale fluctuations in that variation—raises some key questions (McBrearty and Brooks 2000; Nowell 2010; Shea 2011). Concerning Lubbock's initial framework, we may ask, where should we draw the line between the Old and the New Stone Age? Should a line be drawn at all?

Here it may be emphasized that the Paleolithic–Neolithic scheme continues to be employed in Europe and in adjacent continental and subcontinental areas, primarily Asia and North Africa (see Table 1). Researchers working in Subsaharan Africa and Australia do not even systematically refer to the Old Stone Age or to Paleolithic (see Table 2; on this, more to follow). In particular, in Africa the entire Stone Age is subdivided into Early, Middle and Later Stone Age periods (Barham and Mitchell 2008). In many parts of sub-Saharan Africa, the transition from Middle to Later Stone Age occurs well within Late Pleistocene (i.e. during the latter part of the Ice Age), while the Stone Age itself ends in the Middle to Late Holocene, with the adoption

and spread of agro-pastoralist technological systems of food storage and production, sometimes even alongside iron smelting systems. In Eurasia and much of North Africa, by comparison, archaeologists utilized the Paleolithic–Neolithic sequencing framework to characterize regional technological changes in the transition to agriculture, which occurred in Late Pleistocene or Early Holocene. These transitions likely had independently developed components, along with possible long-distance diffusion–dispersal wave influences, in the Near East and China (Bar-Yosef 2015). Thus Lubbock's terminology has come to facilitate, in contemporary scientific discourse, communication about major transformations—mainly involving Eurasian technological systems, population growth, and niche construction—that roughly coincide with the Pleistocene (Ice Age)–Holocene (recent warm period) transition in global climate about 12 kya.

Learning from the "Paleolithic" terminology's limits: Technological system evolution

The Paleolithic–Neolithic chronological framework is thus a relevant heuristic in certain geographic research contexts. It fails to capture the complexity of biocultural change in East and Southeast Asia. It does not capture the intricacy and richness of archaeologically visible *technological* change across sub-Saharan Africa, from the oldest stone tool traditions to the more recent expansion of agriculture and herding, well after the Pleistocene–Holocene boundary (Barham and Mitchell 2008). In Australia the Paleolithic–Neolithic broad-brush model also fails to foreground the complicated, spatially variable processes of human population change, demographic impacts on prey populations, and intergenerationally persistent ecological engineering, all of which unfolded after human colonization, ca. 50 kya, as the continent's diverse hunter-gatherer societies emerged (Lourandos 1997; O'Connell, Allen, and Hawkes 2010).

In general, it remains highly challenging to explain regional variations in the tempo and mode of prehistoric technological change, which—to be sure—does not follow a linear course over space and time (Vaesen et al. 2016). Even the earliest Paleolithic *technological production systems* entailed that australopithecines and early members of the genus *Homo* had to learn and become habitually competent at remarkably heterogeneous patterns of behavior, each involving specialized sensorimotor interaction with one's surroundings. Consider just the behavioral complexity of provisioning stone tool raw materials and knapping Oldowan flakes, alongside using the resulting flakes and chopper to procure wood and hide materials, while also using them to process, transport, and consume plant and animal foods (Schick and Toth 1994). Technological systems are culturally transmitted, maintained, and modified over time. They contribute to defining diverse human behavioral and ecological domains, which encompass foraging, feeding, territorial defense, and sociality. Technological production can thus yield new in-hand tools, clothing, shelter, heat, and consumable food. It can also create transportation media, decorative objects, or monuments.

Such systems are inevitably constrained by locally available sources of energy and nutrients. Yet they can also evolve and, in turn, alter the prevailing cultural niche. Technological systems sometimes specialize in facilitating social communication and judgment, or in ritualizing group members' simultaneously bodily and social experiences (see BURIAL AND RITUAL). This may be seen in later regional Paleolithic practices of making shell and animal tooth beads, ivory sculptures, musical instruments, stone engravings, or cave paintings. Technological systems shape and are shaped by social bonds and emergent social networks in a larger, intricate context of intensive, often ritualized interactions (White 1992; Whallon 2006). The cultural role of technology in social interaction can vary greatly. At least in more recent prehistory—with the emergence of food storage and culturally institutionalized social inequality—interpopulation differences in technological system complexity and diversity may have very much to do with ideology, ritual, politics, and social organization. In such cases, overall technological complexity may have a limited role in defending territories from competing groups, extracting food resources, and transporting, processing, or storing those sources of calories and nutrients.

What can be learned, then, from the substantial limitations of the "Paleolithic–Neolithic" terminology? At first glance, there would seem to be a simple answer. The chipped stone–ground stone–bronze–iron sequence may be argued to offer an iconic shorthand representation of how some key technological systems evolved in large parts of Eurasia and North Africa, but not beyond. As noted above, the Paleolithic and Neolithic eras have come to be defined in practice as the successive time frames across which agriculture, food storage, and village life emerged, around the Pleistocene–Holocene climatic boundary, around 12 kya. Moreover, closer scrutiny has revealed that the technological changes that Lubbock originally saw as marking the Neolithic's onset developed gradually, albeit with a long-term tendency, in the later Paleolithic, toward accelerating diversification, which involved emergent complexity. Like most productive scientific terms, "Paleolithic" facilitates concise scientific description and explanation in contexts that had attracted researchers' a priori attention. Often it is the subsequent scholarly endeavors of novel application, critical redefinition, and revision that shed new light on general evolutionary processes and patterns of change that fall beyond the term's scope. Archaeological evidence now generally suggests that most human populations—and the societies they constituted—have been part and parcel of a nonlinear, geographically complex pattern of biocultural evolution. Over 150 years ago, Lubbock presented substantial evidence that our Stone Age prehistory has a very deep antiquity. Today his terminology is but a part of contemporary inquiry into the intricate processes by which human technology, populations, and environments have changed over that deep time frame.

SEE ALSO: Biocultural models; Learning; Neolithic

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