ASSIGNMENT 4

Human Origins

We begin our journey through human prehistory with a glance at the Great Ice Age, at the complicatedclimatic fluctuations of the past 2.5 million years. These changes have been particularly dramatic over thepast 700,000 years, and assume great importance in later prehistory. The second part of Assignment 4 examines the scientific evidence for the origins of humankind, focusing on recent discoveries in tropical Africa. How did humans evolve and why? What behavioral changes are associated with human origins, and what is the archaeological record for human origins?

Important

Please note that Assignment 4 is a two-week assignment. This is to give you sufficient time to complete the Olduvai exercise with your group, one of the most important Web exercises in the course.

WHAT LIES AHEAD?

Assignment Objectives

Having completed Assignment 4, you will be able to:

1. Outline and describe the basic chronology and major climatic fluctuations of the Ice Age, with special reference to the past 128,000 years.
2. Describe the salient features of Oldowan technology and its implications for studying early human behavior.
3. Be able to evaluate the archaeological evidence for the earliest human behavior with special reference to the archaeological record at Olduvai Gorge.

Work required

This assignment requires you to:

Complete 5 Web-based exercises, one on the Ice Age, the others on hominid fossils, stone tool technology, and Olduvai Gorge. Note that the Olduvai exercise spans two weeks.

Respond in the Study Guide to the (short) questions, where indicated.

LECTURE 1: HUMAN ORIGINS

This week's lecture provides important general background. We:

- Describe the early history of research into human origins, with special reference to the Leakey family.
- Describe and show pictures of some of the major sites, among them Olduvai Gorge and Koobi Fora.

The Videoclip on the Web introduces the subject matter of Assignment 4. You might care to view this now. . . Then read on here. . .

LECTURE 2: PALAEOANTHROPOLOGY

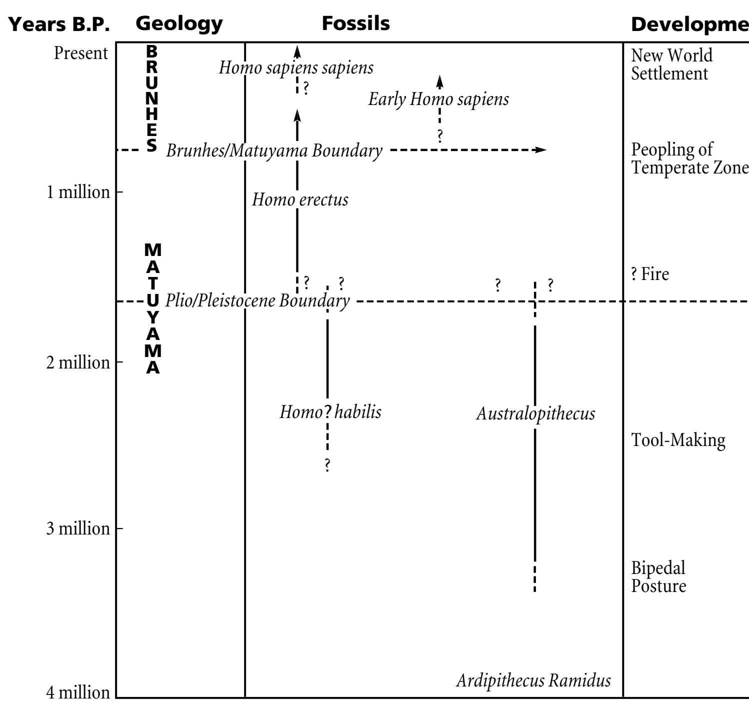
The archaeology of human origins is a complex multidisciplinary enterprise. This lecture describes and analyzes some of the difficulties of studying the subject. We pay particular attention to two important topics:

First, how do archaeologists distinguish between artifacts of human manufacture and flaked stones of natural origin. Second, how does one excavate an early hominid cache, camping, or kill site? What methods are most productive and how are the finds analyzed?

CHRONOLOGICAL TABLE

The Chronological Table below is the first of a series of cumulative chronologies of human prehistory. Each of these tables is for your reference, as we do not intend to spend a lot of time on dating here. Take a careful look at this table, and note the time scales for the various hominid forms discussed in the Assignment, the time scale for major developments such as toolmaking, and the major biological and cultural developments in the right hand columns. The major geological and climatic framework appears at left.

CHRONOLOGICAL TABLE



Now Read on...

STUDYING THE ICE AGE FRAMEWORK

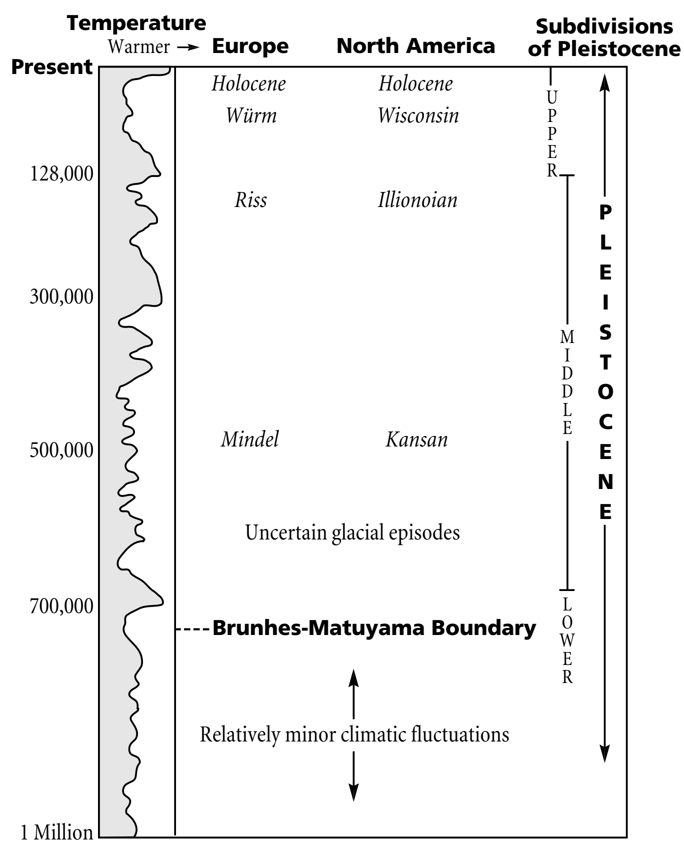
As we saw in Assignment 2, a combination of deep sea cores, pollen analyses, and geological studies provide us with the critical framework we need for linking the events of the Ice Age with human prehistory.

Clearly, many details of the Ice Age are irrelevant for our very general purposes. For most of the past, and certainly until about 50,000 years ago, the human population of the Old World was infinitesimal by today's standards, probably only a few hundred thousand people. But the scattered human bands that did flourish were affected by short- and long-term climatic change both in very general ways and as important members of their local ecosystem. Here we are concerned with global changes in Ice Age climate and how they affected ancient societies.

- First, we will look at the general pattern of Ice Age climatic change over the past 2.5 million years, using mainly data from deep sea cores.
- Then we will examine the last interglacial and the last (Würm) glaciation in considerable detail. This is because the closing 128,000 years of the Ice Age, the period covered by the last interglacial and the Würm are comparatively well known, and also of great importance for understanding the spread of modern humans all over the globe.

THE GENERAL FRAMEWORK

Let's start with the general outline. The Table (4.2) provides you with this framework. Please study it closely and note the following:



1. The so-called Brunhes-Matuyama boundary, which represents the moment when the earth's magnetic field changed from being reversed (before 730,000) to its normal, present day, polarity. The beginning of the Brunhes is clearly marked on the diagram as a base line for later climatic changes.
2. Climatic changes until about 800,000 years ago were relatively minor. Since then, glacial periods have occurred about every 90,000 years.
3. There have been at least nine glacial periods. For at least 70% of the past 730,000 years, the world's climate has been in transition between warm and cold or vice versa.
4. The Upper Pleistocene, a term we use occasionally, began 128,000 years ago.
5. The names of the major glaciations in North America and the Old World, which we will use frequently.

To test yourself, answer the following questions—one or two lines only:

What are the major geological terms used to describe the Ice Age?

Name the last three European glaciations and their North American equivalents.

What are two major ways of studying Ice Age climatic change?

Describe each in one or two sentences.
(You may have to consult Chapter 6 of *Archaeology.*)

Then move on . . .

Web exercise 4-1: The Ice Age
(60 minutes)

This exercise is designed to show you some of the dramatic changes in Ice Age climate during the past 100,000 years, reconstructing climate and major environmental zones of the world during the height of the Würm glaciation, when Neanderthals and modern humans inhabited the earth. The exercise has two stages:

1. The first stage animates the changes in ice sheets, sea levels and vegetational zones during the cold millennia and at the end of the Ice Age. This highlights the complicated changes that took place and the relationships between them.
2. The second reconstructs the global environment 20,000 years ago, at the height of the last cold snap of the Ice Age, and relates this to the challenges of human settlement, to the needs of people living in such an environment, with bitterly cold nine-month winters.

When you have finished this exercise, come back to the Study Guide and read on . . .

HUMAN BEGINNINGS

The origins of humankind have fascinated scholars for centuries, a search that was once shackled with the chains of theological dogma. Then, in 1859, Charles Darwin's Theory of Evolution and Natural Selection opened up a limitless expanse of prehistoric time for the complicated processes of human evolution. The length of the human past has expanded dramatically during the past half-century. As recently as 1959, people thought in terms of 100,000 to 200,000 years. Now a date of 2.5 million years for the first appearance of *Homo* is widely accepted.

In this Assignment, we can but examine the highlights of the many controversies that surround human origins. Let's begin, however, by identifying two areas of common agreement:

- There are many similarities in behavior and physical characteristics between the hominids (members of the family Hominidae, which includes modern humans, earlier human subspecies, and their direct ancestors) and their closest primate relatives. These can be explained by identical characteristics that each group inherited millions of years ago from a common ancestor.
- It is almost certain that humans originated in tropical Africa, since this is where most species of apes are to be found.

Disagreements surround:

- The fossil and archaeological evidence for human evolution and very early human behavior.
- The changes in human behavior that served to distinguish hominids from their nonhuman primate relatives.

We focus on the disagreements here, as they are the core of the problem of human origins.

The material is organized into four topics. First, we cover the history of research into human origins, with some background on the Leakeys. From there we examine the fossil and archaeological evidence for the first toolmaking hominids. Lastly, we evaluate the hypotheses surrounding the origins of human behavior.

Please read on . . . .

RESEARCH INTO HUMAN ORIGINS

Anthology section: "History of Research." Read this passage in its entirety.

When you have finished, read on here . . .

FOSSILS, DATES, AND EVOLUTIONARY SCHEMES

In this section, we trace three anatomical strands—anatomical, chronological, and evolutionary—and will take you through them in a sequence of learning activities. We strongly recommend that you plan to go through this section in one session, to ensure continuity.

We begin with two readings:

1. ***World Prehistory: A Brief Introduction.*** Read pp. 44–57.

Next, we go to the Anthology, because the account in the textbook is already out of date and we want to go into more detail:

2. ***Anthology section: Human Evolution from the fossil evidence. Read this in its entirety, consulting the evolutionary chart accompanying the reading.***

The important thing to realize is that the ladderlike schemes of a generation ago have now given way to much more elaborate, bushlike formulations, which allow for a great diversity of hominids after 4 million years ago.

Now a web exercise:

3. ***Web exercise 4-2: Introducing the skeletons in your closet***
(30 to 40 minutes)

This exercise is designed to familiarize you with your distant hominid relations. The exercise presents basic information on each hominid form. In additional you can examine the cranial morphology of each species as well as artists' reconstructions of what we believe these beings looked like in the flesh. Review the information presented and make notes as necessary in order to incorporate this information with your reading material for later use.

When you have finished, read on here:

THE ARCHAEOLOGY OF HUMAN ORIGINS

Now it's time to delve into the archaeological record in much more detail, to examine the record of human behavior at Olduvai and other major sites.

Let us say at once that the sites and artifacts we describe are very ancient indeed, to the point that it is impossible to draw meaningful analogies between modern hunter-gatherers or living non-human primates and traces of human behavior found in the ground. This means that archaeologists have used a variety of minute, and often specialized, methods to probe and interpret the concentrations of animal bones and stone artifacts found at Olduvai Gorge and elsewhere. These methods will become apparent in the work that follows. Again, a sequence of learning experiences, mainly on the Web, as follows:

1. *World Prehistory.* Read pp. 57–61 (first paragraph only).

This passage covers the simple technology of the first humans.

2. Web exercise 4-3: Principles of Lithic Technology
(30 to 45 minutes)

Exercise 4-3 introduces you to the fundamentals of stone tool manufacture, from the basics of fracture mechanics through the main toolmaking methods used by people through time and throughout the world. Finally, we introduce you to the three main types of the earliest stone tools—such as those found at Olduvai and elsewhere in East and Southern Africa.

3. Web exercise 4-4: The Formation of Olduvai Gorge
(30 to 45 minutes)

This exercise explores the reasons why East Africa has been such a rich area for the discovery of early hominid sites and remains. We begin with an overview of the entire East African tectonic region—the geological and tectonic context within which sites like Olduvai Gorge, Omo, Koobi Fora, and Hadar were formed. We then zoom in to examine the formation processes of the Olduvai Gorge region, illustrating the cycle of deposition and erosion that has made it one of the premier hominid sites in the world. Review the developmental sequence for Olduvai carefully, as it provides clues for the problem posed in Exercise 4-5.

4. Web exercise 4-5: The Archaeology of Olduvai Gorge
(4 to 6 hours)

4–5 is the culmination of Assignment 4 and straddles two weeks.

Complete instructions and background briefing appear in:

Anthology section: "The Olduvai Exercise."

Anthology section: "Oldowan technology"

When you have finished your 2-page essay specified in the briefing, please return here and read on . . .

THE EVOLUTION OF HUMAN BEHAVIOR

Perhaps this is the most controversial subject of all, the one where academic titans clash. How did humans become "human" and how do you define "human?" A summary of the issues appears in:

World Prehistory . Read pp. 38–44, 61–67.

You have now completed Assignment 4.

WARNING!

Your mid-quarter paper is due this week (for deadline see Course Information Sheet or the Anthro 3 Web Page). Be sure to turn this on deadline with a copy of the cover sheet at the front of the Study Guide attached.

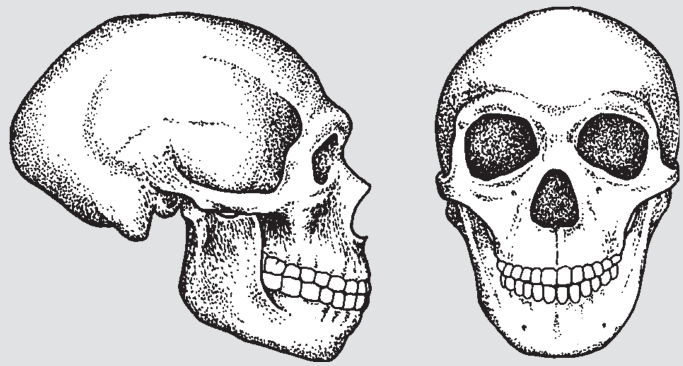
END OF ASSIGNMENT 4

ASSIGNMENT 4: ANTHOLOGY

1. HISTORY OF RESEARCH

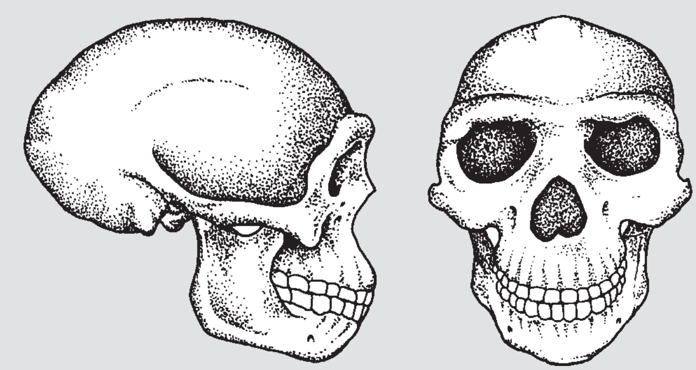
The discovery of our early ancestors has a long and colorful history that begins with the discovery of the bones of extinct animals in association with humanly manufactured stone tools in the eighteenth and nineteenth centuries. Two major discoveries in the mid- to late-nineteenth century revolutionized the archaeology of human origins.

The first was the discovery of the Neanderthal skull in a German cave in 1856. This heavily built, beetle-browed skull was quite unlike any known modern cranium. Some scientists thought it was from one of Napoleon's soldiers, others that it was the skull of a pathological idiot. But the great biologist Thomas Huxley, famous for his ferocious defense of evolutionary theory, studied the Neanderthal find in minute detail. In his immortal *Man's Place in Nature* (1863), he wrote an elegant description of the skull when compared to that of a chimpanzee. Huxley believed the Neanderthal skull showed that there was an anatomical relationship between humans and apes, and suggested that the primeval human ancestor might have been ape-like.



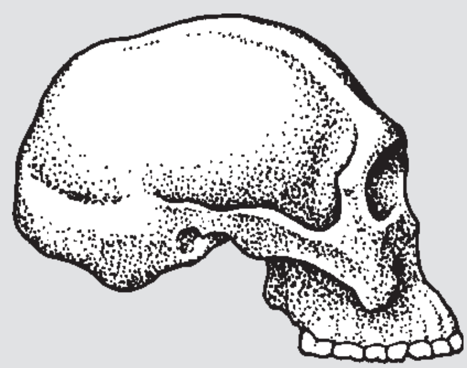
Neanderthal skull, showing salient features

There ensued a search for a so-called "Missing Link," the transitional ape-like human that was the evolutionary bridge between apes and people. It was the search for this elusive creature that took Dutch surgeon Eugene Dubois off to remote Java in south-east Asia in 1890. A year later he made the second great nineteenth century fossil discovery, an ape-like human primitive in appearance but with modem limbs. Dubois' critics did not believe him and dismissed his finds out of hand. It was not until similar human beings came to light in China's Zhoukoudian Cave near Beijing in the 1920s that scientists were convinced finally that Dubois' fossils were those of a primeval human. They named this *Homo erectus*, "human being who stands upright."



Homo erectus

In 1924, a young Johannesburg anatomy professor named Raymond Dart received two boxes of fossil bones from a limestone quarry in the Cape Province of South Africa. One of the lumps of cemented rock in the crates held the skull of what looked like a young baboon. It was not until Dart had chipped away the matrix that he realized that the young primate was something very different-an ape-like creature with uniquely human features like smaller teeth and a more rounded head. Dart named his find *Australopithecus africanus*, the "southern ape-person of Africa." Like Dubois, he was ridiculed, for most scientists believed he had found a fossil ape. Dart and an eccentric fossil hunter named Robert Broom discovered many more Australopithecines before World War Il, identifying at least two forms, one a robust type, the other much more gracile. It was not until the late 1940s that Dart was vindicated, and the Australopithecines were identified for what they are—very early hominids.

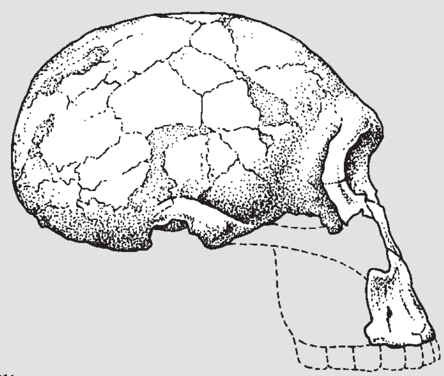


Australopithecus africanus

The Leakeys

If any archaeologists are family names, it is the Leakeys — Louis, Mary, and Richard. Their fossil hunting adventures are the stuff of which dramatic movies are made, adventures that have the added spice of rewriting the evolution of humankind at the same time. We do not have the space to cover all their exploits, but they can be quickly summarized:

- Between 1931 and 1959, Louis and Mary Leakey surveyed and excavated at Olduvai Gorge, Tanzania, on a small scale. They found what they called "living floors," places where very early humans had dropped stone tools and broken bones, but no fossils.
- In 1959, Mary Leakey unearthed a robust Australopithecine, which the Leakeys named *Zinjanthropus*, on an ancient land surface that was subsequently dated by potassium argon dating to 1.75 million years ago. They found further fossils including an anatomically more advanced human, *Homo habilis*, in the early 1960s.
- During the 1970s and 1980s, Richard Leakey surveyed and excavated even earlier sites on the eastern shores of Lake Turkana in northern Kenya. Here, an international team of scientists found not only several Australopithecines, but anatomically more advanced *Homo habilis* individuals as well. Some of these finds dated to 2.5 million years. Richard Leakey also found a *Homo erectus* fossil dating to about 1.5 million years.



Homo habilis

All these finds have given us a tantalizingly incomplete picture of early human evolution, one thwart with controversy.

Lucy

In 1979, Donald Johanson found the skeleton of a diminutive Australopithecine in the Afar region of Ethiopia, far to the north-west of the East Turkana discoveries. This find was dated by potassium argon to between 3.0 and 3.75 million years ago. Johanson and physical anthropologist Tim White claimed that "Lucy" was a new form of Australopithecine, quite different from those found by Dart and the Leakeys. They named her *Australopithecus afarensis*.

Since Johanson's discovery, research has accelerated, especially in Ethiopia, where international research teams led by Tim White of UC Berkeley have found both the earliest hominid in the world, 4.4 million year-old *Ardipithecus ramidus* and *Australopithecus garhi,* a later (2.5 my-old) hominid of previously completely unknown form (see below).

2. HUMAN EVOLUTION FROM THE FOSSIL EVIDENCE

4.5 to 3 million years ago (MYA)

After six million years ago, molecular biology tells us the last common ancestral hominoid stock split into two main lineages: the ancestors of chimpanzees and the ancestors of humans. The details of this split remain a complete mystery, largely because fossil beds dating to this critical period are very rare in Africa.

In 1925, a young anatomist named Raymond Dart caused a sensation when he identified a fossil primate from Taung in South Africa, which displayed both apelike and human features. He named this primate *Australopithecus africanus* ("southern ape-human of Africa"). For a quarter century, Dart's colleagues refused to believe that *Australopithecus* was a potential human ancestor and dismissed it as an ape. Apelike and standing upright, but with humanlike teeth, and in both gracile and robust forms, Dart's ape-humans remained an evolutionary enigma until the 1950s, when a torrent of new discoveries placed the australopithecines very close to the human line. Today, there can be little doubt that much of our common ancestry is shared with various, and confusing, forms of Australopithecines, described below.

The ladderlike evolutionary schemes of a generation ago have now given way to highly tentative studies of early human evolution completed by reconstructing precise evolutionary relationships from fossil specimens, a process fraught with difficulty when bone fragments are the raw materials. It is a matter of fine and careful judgment, the weighing of anatomical details, the weighting of different characteristics, and the assessment of chronology and stratigraphy. The problem is complicated by an extremely thin fossil record between 4 and 1 million years ago, representing less than 1500 individuals. Most of these are single teeth found in fossil-rich South African caves. Very few are skull fragments or jaws, the most valuable of all fossil finds. During this three-million-year time period, our ancestors went through dramatic transformations, visible only through an incomplete paleontological lense. We know that many hominid forms flourished in tropical Africa during this period. Which of them, however, were direct human ancestors? We can only achieve an understanding of human evolution by getting to know as many species as we can, and this task has hardly begun. The summary of fossil hominids which follows is certain to be outdated within a few years (see Table).

Most paleoanthropologists now believe that East Africa was the main crucible of early human evolution, largely because this is the area which has yielded the greatest diversity of primordial hominids. Five to four million years ago, the now-desertic regions of Ethiopia and northern Kenya were open savanna grassland, teeming with herds of antelope and other mammals, hunted by both predators and our remote hominid ancestors. And it is here that the earliest known hominids have been found.

Ardipithecus ramidus

The earliest known hominid was a small creature, which stood upright, with thin-enameled teeth and a skull closer to those of apes, suggesting close links with ancestral chimpanzees. We know little of this remote, small-brained ancestor, which was found by paleoanthropologist Tim White in a 4.5 million year-old layer at Aramis in the arid Awash region of Ethiopia. White and his colleagues named their find Ardipithecus ramidus, to distinguish it from later, and different, Australopithecines. Fragments of about 17 individuals are known.

Ardipithecus ramidus apparently lived in more wooded terrain than many of its successors and must lie close to the first hominids to diverge from the African apes. This still little-known, probably bipedal hominid was related to, or even ancestral to, two later East African forms: *Australopithecus anamensis* and *Australopithecus afarensis.*

At the time of writing, there are unconfirmed reports of hominid discoveries dating to earlier than 5 million years ago, but they are still being analyzed before publication.

Australopithecus anamensis

Australopithecus anamensis (anam is "lake" in Turkana) is the name given complete upper and lower hominid jaws, some teeth, and limb fragments of almost 80 individuals from Allia Bay and Kanapoi on Lake Turkana, Kenya. These fossil finds date to about 4 to 4.17 million years ago. The jaws display parallel sides, like those of apes, whereas human mandibles are wider in the back. The ear holes are smaller and also more apelike. *A. anamensis* is a mosaic of apelike and humanlike anatomy, for the limbs are far more human-looking. The hind limbs are thick enough to support the extra weight of walking on two feet. Measurements of the hind limb suggest the hominid weighed between 47 and 55 kg (104 and 121 pounds).

A. anamensis was notably primitive anatomically, with less mobile hands than the later *Australopithecus afarensis*, but was fully bipedal. However, this hominid had short legs and was not as eficient a walker as modern humans.

Australopithecus afarensis

Australopithecus afarensis is best known from the Hadar region of Ethiopia, also from the Laetoli site in Tanzania. When Maurice Taieb and Donald Johanson discovered a remarkably complete skeleton of a small primate at Hadar, on the Awash River, they named it Lucy. Lucy was only 1.0 to 1.2 m (3.5 to 4.0 feet) tall and 19 to 21 years old. Nearby, they found the remains of at least 13 males, females, and children. Lucy herself has recently been dated to 3.18 million years ago by means of a variant of potassium argon dating that uses computerized argon laser fusion. A nearly intact *A. afarensis* skull and arm bones from several other males have come from another Awash location about 1.5 km (1 mile) upstream; they date to about 3 million years ago, some 200,000 years later than Lucy. This important find hints that all the *A. afarensis* fragments found over the past 20 years are from a single australopithecine species, although some authorities challenge this assumption.

Australopithecus afarensis displays considerable size variation. Some individuals stood 1.5 m (5 feet) tall and probably weighed approximately 68 kg (150 pounds), a far cry from the small, slender Lucy. These creatures, however, were powerful, heavily muscled individuals, thought to be as strong as chimpanzees. *Australopithecus afarensis* was an anatomical mosaic, bipedal from the waist down, arboreal in the upper part of the body. All were fully bipedal, with the robust, curved arms associated with tree climbers. The arms were slightly longer for their size than are the arms of humans. They had humanlike hands, except that their fingers were slightly more curved. The Hadar hominids had brains approximating the size of chimpanzee brains, ape-shaped heads, and forward-thrusting jaws. There is no evidence that they made tools.

The Hadar finds confirm that the fundamental human adaptation of bipedalism predates the first evidence of toolmaking and the expansion of the brain beyond the level found in our nearest living relatives, the African apes. Bipedalism also implies that later hominids were preadapted (had evolved sufficiently) to utilize their hands for toolmaking.

Originally, experts thought *A. afarensis* was confined to East Africa. French paleontologist Michel Brunet has discovered a 3.0- to 3.5-million-year-old fossilized hominid jaw with seven teeth at Koto Toro in Chad, in the southern reaches of the Sahara. The Koto Toro hominid teeth bear a strong resemblance to those of *A. afarensis*. The Chad hominid flourished in a savanna-woodland environment, much wetter than the arid landscape of today.

Koto Toro is the first australopithecine find west of East Africa's Rift Valley and debunks a long-held theory that the great valley formed a barrier separating ape populations and causing those in more open country to move from the trees onto the ground. The evolutionary picture was much more complex than that, witness a recent discovery of a complete Australopithecine skeleton that may also be *A. afarensis* at Sterkfontein in South Africa.

Many scientists consider *A. afarensis* a primitive form of the australopithecines which displayed considerable anatomical variation yet was hardy enough to adapt to harsh, changing savanna environments and survive for nearly a million years.

Laetoli: Footprints of A. afarensis

Dramatic confirmation o*f A. afarensis*' bipedalism comes from fossil-bearing beds at Laetoli in northern Tanzania, excavated by Mary Leakey and potassium-argon-dated to 3.75 to 3.59 million years ago. They have yielded not only the bones of extinct animals but also the incomplete jaws and teeth of at least 13 hominids, classified as *A. afarensis*. The footprints came from the buried bed of a seasonal river, where thin layers of fine volcanic ash once formed a pathway for animals traveling to water holes. The hardened surface of the ash, dated to more than 3.59 million years ago, bore the footprints of elephants, rhinoceroses, giraffes, a saber-toothed tiger, and many species of antelope. Mary Leakey also identified trails of prints of two hominids. "The tracks," she wrote, "indicate a rolling and probably slow-moving gait, with the hips swiveling at each step, as opposed to the free-striding gait of modern man." The two hominid trails lay about 25 cm (10 ins) apart and had probably been laid down at different times. The feet display well-defined arches and distinctive heel and toe prints made by upright-walking individuals about 1.4 m (4 feet 7 ins) and 1.49 m (4 feet 11 ins) tall.

Without question, however, there were several as-yet-largely-unknown hominid forms flourished in eastern Africa before 3 million years ago, perhaps the most widespread being *A. afarensis.*

Fossil evidence: 3.0 to 2.5 mya

Somewhere around that time, the descendants of *afarensis* split into lines. At this point, the evolutionary plot really thickens. One line comprises the more gracile *Australopithecus africanus*, first identified by Raymond Dart in 1925 and known entirely from South Africa, far from the putative East African cradle of humankind. The second line held at least three species of robustly built Australopithecines, somewhat later than *africanus*, which became extinct about 1 million years ago. There are probably other, still undescribed lines. With this diversification, we emerge into a more complex chapter in human evolution, marked by geographic and biological diversification and many competing theories. As British physical anthropologist Chris Stringer once put it: "The field is littered with abandoned ancestors and the theories that went with them."

Gracile Australopithecines: Australopithecus africanus

Australopithecus africanus was a gracile, highly mobile hominid, marked in fossil form by small, almost delicate skulls and prognathous (jutting-out) faces. Found entirely in South Africa, *A. africanus* is an evolutionary mystery, for no one has yet found this form in East Africa, where *A. afarensis* flourished, even if it ultimately evolved from this widely distributed ancestor. It could be an evolutionary experiment that went nowhere, or even have been among the first of a doomed line of robust hominids.

Robust Australopithecines: A aethiopicus, A. boisei, and A. robustus

The robust australopithecines, known by several taxonomic labels, lived between 3 and 1 million years ago. Found in both eastern and southern Africa, they are remarkable for their heavy build. These hominids had large teeth and small brains and were specialized for the chewing of coarse, fibrous plant foods. As a group, these squat, heavily built hominids were very diverse.

Australopithecus garhi

A recently discovered, large-toothed, small-brained hominid with an ape-like face defies classification within either the gracile or robust Australopithecine lines. Working the arid washes of the Ethiopia's Awash desert, a team of 40 researchers from 13 countries have recently unearthed teeth and skull fragments from yet another hominid form, dating to about 2.5 million years ago. The new hominid, named *Australopithecus garhi* (*garhi* means "surprise" in the local dialect) stood about 1.46 m tall (4 feet 10 ins) and had protruding features, not unlike those of a chimpanzee. The lower molars are three times the size of those of modern humans, the canines almost as large. A *garhi's* brain was only a third the size of that of a modern human. The legs were long and humanlike, while the arms were long and more like an ape's. The hominid was an efficient scavenger. Bones of antelope and other large animals found only a few feet away display cut marks from stone tools, the earliest known instance of hominid butchery of animals. Unfortunately, no stone tools were found close to the fossil remains, but surface finds of crude stone flakes and cobbles have come from a nearby lake bed level dating to about 2.5 mya.

Australopithecus garhi is a remarkable find, which will renew debate over the identity of the very first human toolmaker. That this hominid was eating meat suggests that a switch to a high energy, high-fat meat diet was under way. This, in turn, may have led to an increase in brain size among some hominids, which occurred only a few hundred thousand years later.

The latest player on the evolutionary field is an enigma. With its apparent toolmaking and meat-eating propensities, *A. garhi* could conceivably be the exclusive ancestor of the *Homo* family tree and technically the first human. No one, least of all Tim White, is prepared to make such a claim on so little fossil evidence. What we do know is that a far-from-robust Australopithecine derived from *A. afarensis* survived until at least 2.5 mya. But whether this form participated in a rapid evolutionary transition, or series of transitions into an early form of *Homo* remains a complete mystery. What we do know is that major changes to the hominid skull and face occurred after two-and-a-half million years ago, many of them as a direct consequence of brain enlargement. New behavior patterns connected with obtaining more meat and marrow using stone tools may have played a highly important role during what may have been a short, and highly critical period of human evolution.

Early Homo: 2.5 to 2.0 mya

Louis and Mary Leakey were the first to identify the first hominid that was classified as early *Homo*—at Olduvai Gorge in 1960. They named their fragmentary discovery *Homo habilis*, "Handy Person," a label that commemorated the assumed toolmaking abilities of these hominids. Then Richard Leakey found the famous Skull 1470 in East Turkana, a large-brained, round-headed cranium that confirmed the existence of *H. habilis* in no uncertain terms.

If you had encountered *H. habilis* 2 million years ago, you would have seen little to distinguish the new hominid from *Australopithecus*. Both were of similar height and weight, about 1.3 m (4 feet 3 inches) tall and about 40 kg (88 pounds). Both were bipedal, but *H. habilis* would have looked less apelike around the face and skull. The head was higher and rounder, the face less protruding, the jaw smaller. Some of the most significant anatomical differences involved the more even and less specialized teeth. The molars were narrower; the premolars smaller; and the incisors larger and more spadelike, as if they were used for slicing. However, microscopic wear studies of the teeth have shown that both *Australopithecus* and *H. habilis* were predominantly fruit eaters, so there does not seem to have been a major shift in diet between the two. *H. habilis* had a larger brain, with a larger cranial capacity between 600 and over 700 cc, in contrast with those of australopithecines, which ranged between 400 and 500 cc.

Thigh and limb bones from Koobi Fora and from Olduvai confirm that *H. habilis* walked upright. The hand bones are somewhat more curved and robust than those of modern humans. This was a powerful grasping hand, more like that of chimpanzees and gorillas than of humans, a hand ideal for climbing trees. An opposable thumb allowed both powerful gripping and the precise manipulation of fine objects. With the latter capacity, *H. habilis* could have made complex tools. There was probably considerable difference in size between males and females.

H. habilis' skeletal anatomy gives a mosaic picture of both primitive and more advanced features, of a hominid that both walked bipedally and retained the generalized hominoid ability to climb trees. A telling clue comes from one Olduvai's specimen's upper arm bones, which, like Lucy's, are within 95 percent of the length of the thigh bone. The chimpanzee has upper arm and upper leg bones of almost equal length, whereas modern human upper arms are only 70 percent of the length of the upper leg bones. Almost certainly *H. habilis* spent a great deal of time climbing trees, an adaptation that would make them much less human in their behavior, and presumably in their social structure, than had been assumed even a few years ago.

H. habilis, like many taxonomic labels, accommodates what may actually be two or more early human species. The resulting proliferation of hominid names reflects a concern with documenting an anatomical variation which far exceeded possible differences between males and females. For example, *H. habilis* may have lived alongside another East African form, *Homo rudolfensis*. For clarity, we retain the generic term *H. habili*s here but stress that it disguises considerable morphological variation, especially after 2 million years ago, when new human forms were evolving in Africa, and perhaps in Asia too.

A Burst of Rapid Change?

Our scientific predecessors thought of evolution as a gradual and progressive mechanism. The early East African fossils suggest a very different scenario, coinciding with that of the current view of evolution as punctuated equilibrium—long periods of relative stability punctuated with bursts of rapid change caused by new, selective pressures resulting from altered conditions, perhaps environmental change or alterations in the organism itself.

Such a burst of rapid change could have taken hold during the brief 500,000 years that separate *A. garhi* from *H. habilis*. Whoever was the first toolmaker, the development of stone tool techbnology gave its inventors a major advantage over other hominid species. Stone hammers and flakes let them exploit predator kills, shift to an energy-rich, high-fat diet, which could lead to all manner of evolutionary consequences. During the millennia that separated early *Homo* (*H. habilis*) from *H. erectus*, who appeared in East Africa about 1.9 million years ago. Brain size increased from about 450 cc in *A. afarensis* to 1,000 cc in *H. erectus*. There were further modifications in hips and limbs for bipedal locomotion and a reduction in sexual dimorphism (size difference due to sex). The primitive body form and sexual dimorphism characteristic of earlier hominids vanished only with the emergence of the much more advanced *H. erectus*. But what caused this change of evolutionary pace remains a mystery, although some authorities suspect climate change, especially cooler temperatures, played a role.

Who was the first human?

A generation ago, human evolution was thought of as a ladder through time, with an apelike ancestor at the base and modern humans at the top. As for humans, they first appeared at the moment when toolmaking began. This was the reasoning that caused the great controversies of the 1960s as to who was the earliest toolmaker. Was it *Australopithecus*, or some closely related hominid form, like the hopefully named *Homo habilis*? As the pace of discovery accelerated, it soon became apparent that there were several hominid forms around at the time when toolmaking began, making identification of the first "human" an even more challenging task.

In recent years, four criteria have been generally used to assign a fossil to the genus *Homo*:

- An absolute brain size of 600 cc,
- The possession of language, identified from casts of the brain patterns on the inside of the brain case,
- The possession of a modern, humanlike precision grip and an opposable thumb,
- The ability to manufacture stone tools.

There are serious problems with all of these criteria. Absolute brain capacity is of dubious biological importance. We now know that evidence of language cannot be inferred from a brain cast. Furthermore, we still do not know much about the range of precision grips found among early hominids. Stone tools are an inconclusive criterion to use, simply because, 2.6 million years ago, both early *Homo* and robust Australopithecines flourished in the same area where the earliest artifacts are found.

Hominid evolution involves a far greater level of species diversity than was previously thought. Human evolution can be seen as one or more adaptive radiations (a burst of evolution, in which a single species diverges to fill a number of ecological niches, the result being a variety of new forms) rather than a simple, one-way evolution of successive species. This view stems from cladistics, an analytic system for reconstructing evolutionary relationships, first proposed in the 1950s. Classical evolutionary analysis is based on morphological similarities between organisms. So is cladistics, but with a difference: Cladistic analysis concentrates not only on features that identify common ancestry but also on those that are derived independently and are unique to specific lineages. Inevitably, cladistics tends to emphasize diversity over homogeneity.

A cladistic definition considers the human genus a group of species that are more closely related to one another than to species assigned to another genus. This interpretation insists that the human genus is monophyletic, that is with all its members ultimately descended from a common ancestor. Wood and Collard define the human genus "as a species, or monophylum, whose members occupy a single adaptive zone." Using this definition, they carried out a cladistic analysis of all the known fossil *Homo* species and devised a cladogram that separates all the Australopithecine forms, *Homo habilis* into one genus, and later humans, starting with *Homo erectus*, into another. Their intricate statistical analyses suggests that enough is known of body size and shape, locomotion, development, and relative size of chewing apparatus to divide fossil hominin adaptive strategies into two broad groups:

- The Australopithecines and *Homo habilis* (also *H. rudolfensis*) belong in a group of hominids with a relatively low body mass, a body shape better suited to a relatively closed environment, and a postcranial skeleton that combined terrestrial bipedalism with expert climbing. The teeth and jaws of these hominids are well adapted to chewing and biting a varied and mechanically demanding diet. *Australopithecus* teeth and upper leg bone studies show that the rate of development (and dependence) of young hominids in this group was closer to that of modern African apes. The tooth development of *H. habilis* and *H. rudolfensis* also appears to have been closer to that of African apes, as if their development period was also shorter than that of modern humans.

- *Homo erectus* and contemporary and later human forms belong in a second group, marked by a larger body mass, a modern, humanlike physique that was adaptive in more open terrain, and a postcranial skeleton consistent with terrestrial bipedalism. The ability to move around in trees was very limited, teeth and jaws had similar mechanical properties to those of modern humans. Development rates were the same as our own.

This definition of *Homo* makes a clear distinction between the hominids of earlier than 1.9 million years ago, and *H. erectus* and its successors who evolved after that date. It implies that a behavioral and evolutionary chasm separates true humans from the many other hominids who flourished in Africa before 2 million years ago. Quite what caused this adaptive shift in human evolution is unknown. Did it correspond with significant climatic and environmental change, with equivalent evolutionary changes in other large mammal groups, or with specific changes in hominid culture? The answers will have to come from a new generation of research.

Hominid evolution can be thought of as a series of adaptive radiations which unfolded over at least 5 million years. The first radiation was of bipedal apes, which lived, for the most part, in the drier parts of Africa. Two later radiations gave rise to what is still called early *Homo* and the robust australopithecines, each with their own adaptive theme. In the case of early *Homo*, expanded brain size played a key role, while the robust australopithecines developed specialized teeth. Although the latter varied greatly in morphological terms, later humans radiated not so much morphologically as ecologically, spreading from Africa and creating distinct geographic populations. This flowering of hominid types is exactly what evolution is about: "an endless production of novel ways of doing things, exploring alternatives, trying out new strategies as conditions themselves shift and change all driven by natural selection." Hominids were no different from other mammals, which began as a slim stem and radiated into distinct branches. We still do not know much about the relationships between such branches.

2. BRIEFING ON THE OLDUVAI GORGE WEB EXERCISE

We must now examine the archaeological evidence for early human behavior at a specific archaeological site, Olduvai Gorge. Although there are earlier sites in the East Turkana area, notably Koobi Fora, a small scatter of fractured bones and stone tools dating to about 2.5 million years ago, Olduvai is the most thoroughly studied, and is ideal for our purpose.

You are presented with a wealth of information in this exercise—more information than you may actually need to solve the problem. There are two keys to successfully completing the exercise. The first is pattern recognition. You are looking for a difference in the composition of the stone tool assemblages between levels at multi-component sites, and between sites (both single component and multi-component) that occur in different geological strata in the Gorge. The stratigraphy of multi-component sites and the stratigraphy of the Gorge provide you with the chronological context within which your tool assemblages occur. The composition of the assemblages give you clues as to the differences in tool industries. The second key to this exercise is focusing your attention on the information that is actually useful in solving the problem at hand. The best way to do this is to do what an archaeologist would do in the same situation. First, take some time to just tour around the Gorge and the sites to get familiar with their vertical and horizontal positioning, and to get a feel for the types of stone tools present at the sites. Next, think about the problem. Break it down into its component parts-what stratigraphic information do you need, what information about the tool assemblages do you need, etc. Then develop a research plan. This plan will make sure that you don't miss information as you go along, but it will also allow you to decide in advance what information to ignore. Finally, come back to the exercise, armed with your research plan, extract the data you need, and write your summary.

Before starting the computer exercise, please read the passage on Oldowan technology below (Extract 3 below). This gives Oldowan technology background to the exercise, which will examine Olduvai from four perspectives. Before starting the exercise itself, jot down the major points that emerged from your reading of these pages, in note form for convenience.

This computer exercise has a number of interlinked features that allow you to tour the Gorge and visit a number of sites. The central node of the exercise is the overview map of the Gorge area. It provides you with information about the locations of all of the fossil localities found in the Gorge. By clicking on the specially marked site icons on the map you can zoom-in to a model of the sites. The site models include plan maps, profile drawings, representative artifact illustrations, and summary tables of the numbers and types of different stone tools found at the site.

Your objective is to do a little deductive detective work. We know from Mary Leakey's work that there are three stone tool industries represented at Olduvai — the Oldowan, the Advanced Oldowan, and the Acheulean. The distinctions between their artifact inventories revolve around the presence or absence of bifaces. The Oldowan has no bifaces, but choppers, flakes, and other tools, while the Advanced Oldowan has some "proto-bifaces," artifacts with flaking on both sides that appear to be early forms of the handaxe, the characteristic artifact of the Acheulian. You can use these tool forms to distinguish between the three. Each of these industries represent stages in the development of hominid technological innovation. Your job, using all of the resources available to you, is to present a reasonable argument as to which sites you believe to represent each stage of development. Your statement should not exceed *2 typed pages*, but may include printouts of tables, maps, and profiles as corroborating evidence. The objectives of this exercise are:

1. To give you a greater appreciation of the complexity of the problem of interpreting early hominid behavior.
2. To provide you with a more in depth understanding of the importance of stone tools as clues to hominid behavior.
3. To give you an opportunity to exercise your observational and inferential skills.

To carry out this exercise, we suggest you follow this procedure:

1. Print out the tool summaries for each level,

2. For multi-component sites, create a chronology by percentages of tool types,

3. By strata, classify tool types into Early 0ldowan, Developed Oldowan, and Acheulian.

You are working in groups, but each person needs to develop a statement independently.

Life in the Olduvai Computer Environment

1) The overview map gives you a large scale bird's-eye view of the gorge area. You may use this map to navigate to specific portions of the Gorge.

2) Click in an area of the overview map in order to zoom-in on that portion of the Gorge. In the zoom view, you will get a more detailed map of a small portion of the Gorge. This detail map contains triangular icons that indicate the locations of known archaeological sites. There are six (6) sites for which the triangles are large, and have gray cross-hatching within them. You can click on these large triangular icons to zoom into a summary of the information for those 6 sites. Note that in the area of the confluence of the two main branches of the Gorge, there is an additional level of detail that you can get to from the detail map by clicking within the area that turns black when you move the mouse within it. This higher detail map was necessary because there are so many sites in that part of the Gorge. In fact, three of the sites that you have access to are located in this region.

3) The site information is divided into 5 sections. The first section is a plan map of the site showing the lay of the land, and the locations of the excavation units. In some cases, you can click on a unit and zoom into a detailed plan drawing of the locations of artifacts within the different levels of the unit. This information is not available for all sites or all units (unfortunately).

The second section is a representative catalog of the artifacts found at that site. The catalog presents a picture of the artifact, and some summary information. From the catalog, you can get to the remaining sections of the site information. There is a button that will take you to the profile drawings for the site. The profile drawings will give you information on the stratigraphy of the site. Clicking on any of the stratum symbols will take you to a brief written description of the stratum. The stratum information will tell you about the consistency of the fill, the general artifact density, and any potassium-argon dates that have been determined. There is also a link that will take you to a tabular summary of the types of tools found at the site, and the frequency and percentages of those tool types by level within the site. This information is critical to completing the exercise. This tabular information can be printed out or saved to a text file. You should print this information out. DO NOT print the catalog cards. You may want to print the site maps or the profile drawings for reference when you write your report later. That is up to you.

To get back to the overview map of the Gorge, just back out the way you went in. There is a button on all of the site plan map cards that will take you back to the detailed map of the region of the Gorge that the site you are looking at is in. You can then click on the "Go Back to Overview' button to zoom out to the overview map. You can quit the exercise by getting back to the overview map (the largest scale map) and clicking on the go next arrow button.

4) Your game plan should be as described above. The key to the exercise is in noting differences in the percentages of the different tool types between sites — the information presented in the tabular summary in each site's catalog. Additionally, you should be looking for tool types that occur in one assemblage, and not in other assemblages — that can be vitally important.

3. OLDOWAN TECHNOLOGY

Everyone has always assumed that the earliest stone technology would be very simple. When the Leakeys found crudely chipped stones in the long-buried lake beds at Olduvai Gorge, the artifacts were indeed nothing much to look at. (The Leakeys called their early tool assemblages 0ldowan, after the gorge where they were first identified.) Most were broken cobbles and flakes, flakes being in the majority. Some Oldowan tools were so crude that only an expert can tell them from a naturally fractured rock, and experts often disagree.

All the Oldowan choppers and flakes strike one as extremely practical implements; many are so individual in design that they seem haphazard artifacts, not standardized in the way later Stone Age tools were. Classifying them is very difficult, for they do not fall into distinct types. The tools cannot be described as primitive since many display a sophisticated understanding of stone's potential uses in toolmaking. We now know that the Olduvai hominids were adept stone toolmakers, using angular flakes and lumps of lava to make weapons, scrapers, and cutting tools. The tools themselves were probably used to cut meat and perhaps wood. Most likely, the hominids made extensive use of simple and untrimmed flakes for many purposes.

Oldowan industries have been found on several sites in East Africa dating to between about 2.6 and 1.5 million years ago. There appears to be relatively little variability between different toolkits, and the artifacts show certain common technological features. All of them were made from cobbles, often struck from lumps, with edges flaked from both sides. Some of these cores may have served as crude choppers, for the toolkit consisted of both heavy- and light-duty tool forms, some modified into crude scrapers. This seems like a very simple technology, but the artifacts show a skilled appreciation of basic stone-flaking techniques and flaking sequences that were envisaged in the mind's eye.

For years, archaeologists thought of the Oldowan as a static technological stage without any perceptible change. As more sites come to light and analytic techniques are refined, though, the Oldowan appears in a different light-as a simple, highly effective technology that grew more complex over time, with the appearance of crude bifacial working, in which cores were flaked on both sides.

Mary Leakey studied the Oldowan choppers and flakes from the early hominid levels at Olduval and divided the artifacts into different morphological forms. Her classification remained unchallenged until Nicholas Toth and a new generation of scholars approached early stone technology from a more holistic perspective. The objective of their studies has been to learn as much as possible about early hominid behavior from the stone artifacts left behind. Such research is founded on every aspect of technology, from raw material acquisition through artifact manufacture and use to the discarding and incorporation of the tools into the geological record. As part of his work, Toth became an expert stone toolmaker and carried out edge wear studies on sites in East Turkana.

Toth emerged from his work with a very different view of the Oldowan. He points out that conventional approaches to the stone artifacts are based on the idea that the makers had premeditated artifact forms in mind. His experiments replicated thousands of Oldowan cores and flakes and led him to argue that much of the variety in Oldowan artifacts was, in fact, the result of flake production. Many of the choppers from Olduvai and Koobi Fora are actually "waste," cores discarded when as many flakes as possible had been removed from them. Toth also observes that the size of the available raw material can profoundly affect the size and variety of choppers and flakes at an Oldowan site.

Toth's experiments with replicated tools revealed that sharp-edged flakes are far more effective for butchering animal carcasses, especially for slitting skin. Flakes, then, were of much greater importance than hitherto suspected- but this does not mean that all choppers were just waste. Some may have served as wood-chopping and adzing tools or for breaking open bones for their marrow. Microwear studies of the few Oldowan flakes made of fine-grained materials have hinted at three possible uses: butchering and cutting meat, sawing and scraping wood, and cutting soft plant matter.

What are the implications of Toth's studies for our knowledge of early hominid cognitive skills? Toth believes our earliest ancestors had a good sense of the mechanics of stone tool manufacture and of the geometry of core manipulation. They were able to find the correct acute angle needed to remove flakes by percussion. Not even modern beginners have this ability; it takes several hours of intensive practice to acquire the skill. Although chimpanzees use sticks and crack nuts with unflaked stones, they rarely carry their "artifacts" more than a few yards. In contrast, the Koobi Fora and Olduval hominids carried flakes and cores over considerable distances, up to 8 miles (13 km). This behavior represents a simple form of curation, retaining tools for future use rather than just utilizing convenient stones, as chimpanzees do. Toth hypothesizes that the hominids tested materials in stream beds and other locations; transported the best pieces to activity areas; and sometimes dropped them there, carrying the rest off with them. He also points out that they must have relied heavily on other raw materials, like wood and bone, and that stone artifacts do not necessarily give an accurate picture of early hominid cognitive abilities.

The archaeologists' traditional view of the Oldowan considers it a "protohuman culture," its simple stone artifacts being a first step on the long evolutionary trail to modern humanity. Perhaps this view has been colored by analogies with modern hunter-gatherers and by overoptimistic interpretations claiming that early hominids aimed and threw stone missiles, shared food, and so on. Another viewpoint argues that the Oldowan hominids were at an apelike grade of behavior, on the grounds that all the conceptual abilities and perceptions needed to manufacture Oldowan tools also appear in ape-manufactured tools like termite-fishing tools and sleeping platforms. Furthermore, like the Oldowan hominids, chimpanzees also scavenge and hunt for game, chasing down small animals, carrying meat over considerable distances, and using "extractive technology" to break open animal bones and nuts.

Chimpanzees, like early hominids, use the same places again and again, pounding nuts at the same locations and carrying food to their favorite eating sites. Even if the specifics vary in some instances and the natural environments are different, the behavioral pattern of Oldowan hominids was generally similar to that of apes. There are, however, two behavioral differences between apes and early hominids. First, hominids were at an advantage in that they were bipedal, a posture that is far more efficient for carrying objects than walking on four limbs. Second, the Oldowan humans were adapted to savanna living, where they had to organize and cover far larger territories in open country than their primate relatives in the forest. In the long term, this requirement may have resulted in new concepts of space and spatial organization, concepts that were definitely reflected in more complex stone tool forms after a million years ago.

Early hominids, with their larger brains, probably would not have adapted or behaved the same way as modern apes. We can be certain that there were significant differences between nonhuman primates and hominids 2 million years ago, but these differences may not be reflected in stone artifacts. Without question, our ancestors became more and more dependent on technology. The opportunistic nature of primeval stone technology contrasts sharply with the better-designed, much more standardized stone artifacts of later humans.