1
DAWN AT TWILIGHT CAVE

High above the western shore of Lake Naivasha, a blue pool on the parched floor of East Africa's Great Rift Valley, sits a small rock-shelter carved into the Mau Escarpment. Maasai pastoralists who once occupied this region in central Kenya called the place Enkapune Ya Muto, or "Twilight Cave." People have long sought shelter there. The cave's sediments record important cultural changes during the past few thousand years, including the first local experiments with agriculture and with sheep and goat domestication. Buried more than 3 meters (10 feet) deep in the sand, silt, and loam at Enkapune Ya Muto, however, lie the traces of an earlier and far more significant event in human prehistory. Tens of thousands of pieces of obsidian, a jet-black volcanic glass, were long ago fashioned into finger-length knives with scalpel-sharp edges, thumbnail-sized scrapers, and other stone tools, made on the spot at an ancient workshop. But what most impressed archeologist Stanley Ambrose were nearly six hundred fragments of ostrich

eggshell, including thirteen that had been fashioned into disk-shaped beads, about 6 millimeters (0.25 inches) in diameter (Figure 1.1). Forty thousand years ago, a person or persons crouched near the mouth of Enkapune Ya Muto to drill holes through angular fragments of ostrich eggshell and to grind the edges of each piece until only a delicate ring remained. Many shell fragments snapped in half under pressure from the stone drill or from the edge-grinding that followed. The craftspeople discarded each broken piece and began again with a fresh fragment of shell.

Why did the occupants of Enkapune Ya Muto take so many hours from more essential activities like foraging just to make a handful of beads? The question is particularly appropriate, since they were not the only ones to pursue this seemingly esoteric activity. More than 30,000 years ago, the stone age people who occupied Mumba and Kisese II Rockshelters in Tanzania and Border and Boomplaas Caves in South Africa also produced carefully shaped ostrich eggshell beads.

Ambrose believes that these ancient beads played a key role in the survival strategy of the craftspeople and their families. In the Kalahari Desert of Botswana, !Kung San hunter-gatherers practice a system of gift exchange known as *hxaro*. Certain items, such as food, are readily shared among the !Kung but never exchanged as gifts. The most appropriate gifts for all occasions just happen to be strands of ostrich eggshell beads. The generic word for gift is synonymous with the !Kung word for sewn beadwork. Although the nomadic !Kung carry the barest minimum of personal possessions, they invest considerable time and energy in creating eggshell beads.

The beads serve as symbols. They represent reciprocity between neighboring or distant bands of people. Should a drought or other

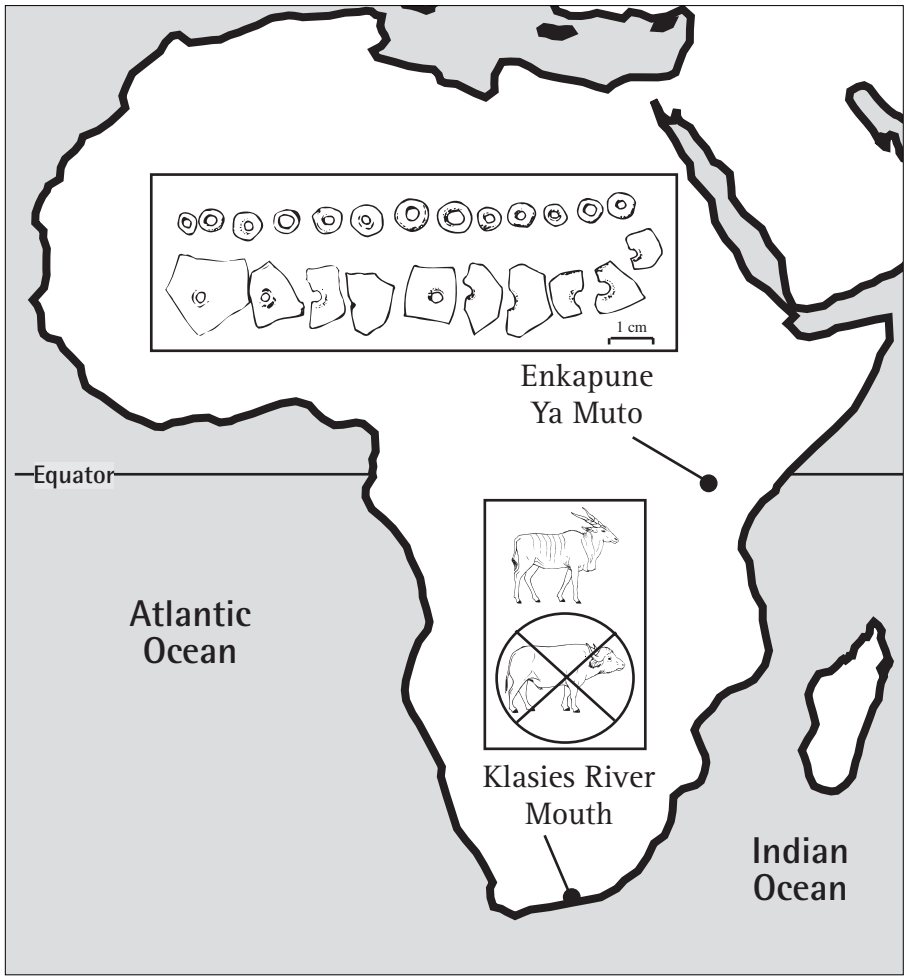

Figure 1.1
The locations of Enkapune Ya Muto and Klasies River Mouth. Enkapune Ya Muto has provided ostrich eggshell beads and bead blanks or preforms dated to about 40,000 years ago. Klasies River Mouth shows that between about 120,000 and 60,000 years ago human hunters preferred the docile eland to the more dangerous buffalo.

sudden climatic or environmental change leave food in scarce supply, a group can move to another group's territory, where they rely on aid and support from those with whom they have established *h.xaro* ties. For the !Kung, beads provide a lightweight, portable token of mutual obligations—the currency of a long-term, long-distance social security system. "They're paying into their health insurance, in a sense," says Ambrose, a professor at the University of Illinois in Urbana. "They're paying insurance to each other."

No one knows whether the toolmakers at Enkapune Ya Muto or the other ancient African sites intended their ostrich eggshell beads to be social gifts. But if these beads were invested with symbolic meaning similar to that of beads among the !Kung, then Twilight Cave may record the dawning of modern human behavior. Communicating with symbols provides an unambiguous signature of our modernity. Within the grand scope of human evolution, symbolic behavior was a very recent innovation. Once symbols appear in the archeological record, as enigmatic geometric designs, as human or animal figurines carved in ivory, or as beads and other ornaments, we know we're dealing with people like us: people with advanced cognitive skills who could not only invent sophisticated tools and weapons and develop complex social networks for mutual security, but could also marvel at the intricacies of nature and their place in it; people who were self-aware.

The deep antiquity of the Enkapune Ya Muto beads is almost certain. Ambrose discovered that ostrich eggshell beads and beads-in-the-making (preforms) were ten times more numerous per cubic meter in the deepest part of the deposit than they were higher up. That could attest to the importance the early inhabitants placed on bead manufacture, but it also reduces the likelihood that the beads are simply

younger artifacts that filtered down into deeper and older sediments with the passage of time and the burrowing of animals. Ambrose argues that the social value attached to eggshell beads by contemporary Kalahari people likewise attests to a deep-rooted symbolic meaning, carried across millennia from a time when far more ancient hunter-gatherer bands were scattered across southern and eastern Africa.

If, as Ambrose conjectures, the Enkapune Ya Muto beads helped to ensure survival during hard times, they may have emboldened early modern people to strike out into riskier environments—perhaps even some beyond Africa itself. "With this social safety net they could do better than people without symbolic means of establishing future permanent ties of reciprocity," he surmises. "You could say it's like weaving lifelines between people, and the lifelines are strings of beads."

The other artifacts from Enkapune Ya Muto represent an initial form of the stone technology associated only with fully modern humans in Africa, after 50,000 years ago. More than any sophisticated stone tool, however, the simple beads, laboriously crafted from ostrich eggshell, suggest that people in eastern Africa at this time had achieved cognitive capacities beyond those of any preceding human population, in Africa or anywhere else. Thus, our evolutionary success and the rich array of cultures from later times may have depended not so much on physical qualities or intimidating weapons as on the intellectual capacity to conceive, create, and communicate in symbols. To understand why evidence from sites such as Enkapune Ya Muto bespeaks a significant departure from all previous human behavior, we must move a bit further back into our African past and travel to the southern tip of the continent.

♛ ♛ ♛

Four thousand kilometers (2400 miles) southwest of Enkapune Ya Muto, the Indian Ocean relentlessly pounds the southern coast of Africa. Where the waves meet steep coastal cliffs, they have scoured out caves in which ancient stone age people could shelter. The most famous caves are clustered about 40 kilometers (24 miles) west of Cape St. Francis and 700 kilometers (420 miles) east of Cape Town, on a 1-kilometer (0.6-mile) strip of coast where the small perennial Klasies River enters the sea (Figure 1.1). The caves are thus known collectively as the Klasies River Mouth site. These cave deposits have produced fossils of early modern or near-modern humans, along with their stone tools and fireplaces, and the remains of the mammals, birds, and mollusks that they ate.

The roughly two dozen human fossils from the caves are admittedly few and fragmentary. Yet, they include key parts of the skull that reveal how anatomically modern these people were. A nearly complete lower jaw, for example, shows that the owner had an essentially modern, short, broad, flat face quite unlike the long, narrow, forwardly projecting faces of the Neanderthals who occupied Europe at the same time, about 100,000 years ago. And a fragment of bone from above one eye socket (orbit) lacks the brow ridge that marks the skulls of primitive members of the human genus. (This piece of bone also exhibits stone tool cutmarks suggesting that the skull was defleshed, perhaps for food. Other human fragments were slashed, bashed, and burned, implying that human parts were sometimes processed like those of antelopes and seals. This suggests to scientists that like some historic people, the Klasies people occasionally practiced cannibalism.)

While the Klasies fossils do vary widely in size, in their basic form they are undeniably modern. The people are plausible ancestors for historic Africans, or for historic people everywhere, and their bones date from as much as 120,000 years ago. With brief interruptions, they lived at Klasies River Mouth from 120,000 years ago until about 60,000 years ago, when the onset of extreme aridity perhaps forced people to abandon the region for tens of thousands of years.

Excavated first by Ronald Singer and John Wymer from the University of Chicago and more recently by Hilary Deacon from the University of Stellenbosch, the Klasies caves preserve abundant kitchen debris of the occupants. These include the shells of mussels, limpets, and other mollusks that can still be collected at low tide nearby. They place the Klasies people among humanity's oldest known shellfish gourmets. The caves are equally rich in fragmentary animal bones and in stone tools that were often flaked from cobbles collected on the beach. Burnt shells and bones show that the people engaged in cooking, and their fireplaces are so common that it seems certain they could make fire at will. Deacon suggests that each fireplace marks the domestic hearth of an individual family and that the people therefore resembled modern hunter-gatherers in nuclear family structure. Yet none of the Klasies Caves has provided ostrich eggshell beads like those from Enkapune Ya Muto, nor have they provided any other object that is unambiguously symbolic.

The animal bones exhibit numerous cutmarks, and they were often broken for the extraction of marrow. The implication is that the Klasies people consumed a wide range of game, from small, greyhound-size antelope like the Cape grysbok to more imposing quarry like buffalo and eland, as well as seals and penguins. The number and location of stone tool cutmarks and the rarity of carnivore tooth marks

indicate that the people were not restricted to scavenging from lions or hyenas, and they often gained first access to the intact carcasses of even large mammals like buffalo and eland.

But the bones also show that the people tended to avoid confrontations with the more common—and more dangerous—buffalo to pursue a more docile but less common antelope, the eland. Both buffalo and eland are very large animals, but buffalo stand and resist potential predators, while eland panic and flee at signs of danger. The Klasies people did hunt buffalo, and a broken tip from a stone point is still imbedded in a neck vertebra of an extinct "giant" long-horned buffalo. The people focused, however, on the less threatening young or old members in buffalo herds. The stone points found at Klasies could have been used to arm thrusting spears, but there is nothing to suggest that the people had projectiles that could be launched from a distance, and they may thus have limited their personal risk by concentrating on eland herds that could be chased to exhaustion or driven into traps. The numerous eland bones in the Klasies layers represent roughly the same proportion of prime-age adults that would occur in a living herd. This pattern suggests the animals were not victims of accidents or endemic diseases which tend to selectively remove the very young and the old, but rather that they suffered a catastrophe that affected individuals of all ages equally. The deposits preserve no evidence of a great flood, volcanic eruption, or epidemic disease, and from an eland perspective, the catastrophe was probably the human ability to drive whole herds over nearby cliffs.

In contrast to Klasies River Mouth, other much younger archeological sites nearby such as Nelson Bay Cave contain many more bones of dangerous prey like buffalo and wild pigs and many fewer of

eland. The reason is probably that by this time, around 20,000 years ago, people had developed projectile weapons like the bow and arrow that allowed them to attack dangerous prey from a distance and therefore to limit their personal risk. The advantage was considerable, because the ancient environment probably broadly resembled the historic one, in which buffalo and pigs greatly outnumbered eland nearby.

The Klasies people not only avoided the most dangerous game, they also failed to take full advantage of other widely available resources. The ages of seals in the Klasies deposits show that the people remained at the coast more or less throughout the year, including times when resources were probably more abundant in the interior. In contrast, much later people like those at Nelson Bay Cave timed their coastal visits to the late winter/early fall interval when they could literally harvest 9- to 11-month-old seals on the beach, and they moved inland when resources became more plentiful there. The ability of these later people to pursue an efficient seasonal strategy probably depended in part on their use of ostrich eggshells as canteens. Fragments of such canteens, with carefully positioned openings to allow water out and air in, have been found in their sites but not at Klasies River Mouth or other sites that are older than 50,000 years. The inability of the Klasies people to transport water may have forced them to remain near the river throughout the year.

Fish have always been common in the offshore waters near Klasies River Mouth, and roosting cormorants, which sheltered in the caves when people were absent, sometimes carried in tiny fish. However, in layers where artifacts and fireplaces indicate intense human occupation, fish bones are all but absent. Fish bones are likewise rare or missing at other comparably ancient sites on the South

African coast, even though the sites were often only a stone's throw from the sea. At much more recent archeological sites like Nelson Bay Cave, fish bones often dominate the food debris, and the difference probably reflects a difference in technology. Only the more recent sites contain probable fishing gear like grooved stones for weighting nets or lines and carefully shaped toothpick-size bone splinters that could have been baited and tied to lines like hooks. In short, only the more recent people undeniably possessed the technology for fishing.

The ancient Klasies people also largely ignored birds, except for the flightless jackass penguins that they could have caught or scavenged on the beach. Gulls, cormorants, and other airborne birds were surely common nearby, but their bones are scarce at human sites until much more recent times. When they finally do appear in large numbers, they are accompanied by bone rods that were probably parts of arrow shafts and by small stone bits (microliths) like those that historic people used to tip arrows. Historic hunters have often demonstrated the utility of the bow and arrow for fowling. The bottom line is that the archeological and faunal evidence together show that South African hunter-gatherers who lived before 50,000 years ago were much less efficient hunter-gatherers than their successors. Archeology demonstrates that more efficient, fully modern hunting-gathering appeared only after 50,000 years ago, among the kinds of people who made the ostrich eggshell beads at Enkapune Ya Muto.

♛ ♛ ♛

These two sites of Enkapune Ya Muto and Klasies River Mouth, separated by four thousand kilometers in space and up to 70,000 years in

time, illustrate a critical conundrum for understanding how, when, and where modern humans evolved. Human fossils from Klasies River Mouth and other African sites and from sites in Israel immediately adjacent to Africa show that people who were anatomically like us had appeared in Africa by 100,000 years ago. Despite their modern appearance, however, these people left artifacts and animal remains which show that they were not fully modern in behavior. It is only after 50,000 years ago that behavioral evolution caught up and it is only afterwards that people were both anatomically and behaviorally modern.

Before 50,000 years ago, human anatomy and human behavior appear to have evolved relatively slowly, more or less in concert. After 50,000 years ago, anatomical evolution all but ceased, while behavioral evolution accelerated dramatically. Now, for the first time, humans possessed the full-blown capacity for culture, based on an almost infinite ability to innovate. They had evolved a unique capacity to adapt to environment not through their anatomy or physiology but through culture. Cultural evolution began to follow its own trajectory, and it took the fast track. Even as our bodies have changed little in the past 50,000 years, culture has evolved at an astonishing and ever-accelerating rate.

Our aims in this book are to outline the evidence for human anatomical and behavioral evolution before 50,000 years ago and to explore the circumstances surrounding the behavioral revolution that occurred afterwards. One obvious question we must confront at the outset is: what sparked the revolution? Unfortunately, there is no conclusive answer. To attempt one, we must look back at other important biological and behavioral changes that occurred along evolution's meandering path from our remotest ape-like ancestor to the curious,

creative reader of this book. Human evolution has followed twists and turns and encountered occasional dead ends. The earliest part of our story still remains rather obscure. This is when some ape-like creature began to walk habitually on two legs. From the time of that pivotal innovation, human evolution can be viewed as a series of at least three and perhaps four sudden and profound events spaced between lengthy stretches of time when little happened.

From Darwin's day onward, most scientists have perceived evolution as a gradual and cumulative process, a slow, stately unfolding of life's history. In 1972, however, evolutionary biologists Niles Eldredge of the American Museum of Natural History and Stephen Jay Gould, now at Harvard University, challenged this perspective. They proposed that conspicuous and long-recognized gaps in the fossil record of past life actually provided vital information about the pace and pulse of evolution. As they wrote in a 1972 article, "Many breaks in the fossil record are real; they express the way in which evolution occurs, not the fragments of an imperfect record." Eldredge and Gould called their hypothesis punctuated equilibrium. Its key idea was that true evolutionary innovations appear suddenly and infrequently. It is at these points of abrupt change, often sparked by major climatic or environmental shifts, that new species tend to arise. Major climatic shifts not only open up fresh ecological opportunities, they also extinguish existing species, clearing the ecological playing field for new ones. Viewed from the present, the fossil record appears to show a sudden inflection after a period of constancy, a species-spawning event captured in a flash of geologic time, which punctuates an otherwise prolonged period of evolutionary equilibrium. In other words, stability is the norm, while speciation (the formation of new species) is the rarer but essential exception.

Evolution, in Eldredge and Gould's view, resembles a roller coaster ride: slow and steady ascents interrupted by breakneck plunges and curves. Just as the ascents occupy most of the brief roller coaster ride, gradual change comprises most of evolutionary time. But punctuations hold all the action and excitement.

New species probably most often arise in small, isolated populations where genetic changes (mutations) are particularly likely to take hold and become dominant. In large populations or in small populations that are in regular contact with others, genetic changes, even advantageous ones, are more likely to be swamped and to disappear strictly by chance. Each of the three or four punctuation events that we propose led up to the dawn of modern human culture occurred when human populations were small and geographically limited by modern standards. Each apparently occurred in Africa, and on present evidence, each appears to mark a coincidence of major biological and behavioral change. The first event occurred around 2.5 million years ago, when flaked stone tools made their initial appearance. These comprise the earliest enduring evidence for human culture, and their emergence probably coincided closely with the evolution of the first people whose brains were significantly larger than those of apes. The second event took place around 1.7 million years ago. The people this time were the first to possess fully human as opposed to ape-like body proportions, and they invented the more sophisticated stone artifacts that archeologists call hand axes. They may also have been the first to venture out of Africa. The third and most weakly documented event occurred around 600,000 years ago, and it involved a rapid spurt in brain size, together with significant changes in the quality of hand axes and other stone tools. The fourth and most recent event occurred

about 50,000 years ago and it was arguably the most important of all, for it produced the fully modern ability to invent and manipulate culture. In its wake, humanity was transformed from a relatively rare and insignificant large mammal to something more like a geologic force.

Archeology demonstrates the radical nature and consequences of the last event, but it says nothing about what prompted it, and it is here that we face a conundrum. Arguably, the most plausible cause was a genetic mutation that promoted the fully modern brain. This mutation could have originated in a small east African population, and the evolutionary advantage it conferred would have enabled the population to grow and expand. This is because it permitted its possessors to extract far more energy from nature and to invest it in society. It also allowed human populations to colonize new and challenging environments. Possibly the most critical aspect of the neural change was that it allowed the kind of rapidly spoken phonemic language that is inseparable from culture as we know it today. This ability not only facilitates communication, but at least equally important, it allows people to conceive and model complex natural and social circumstances entirely within their minds.

Some might object that a neurological explanation for the explosion of culture after 50,000 years ago is simplistic biological determinism, a just-so story or a *deus ex machina* explanation for a paleontological paradox. The idea admittedly fails one important measure of a proper scientific hypothesis: it cannot be tested or falsified by experiment or by examination of relevant human fossils. Human brains had reached fully modern size many hundreds of thousands of years earlier, and skulls reveal little about the functioning of the brain underneath. There is nothing in the skulls of people from shortly before and

after 50,000 years ago to show that a significant neurological change had occurred. The neurological hypothesis does, however, measure up to one important scientific standard: it is the simplest, most parsimonious explanation for the available archeological evidence. And that evidence, as incomplete and imperfect as it is, is what we must rely upon to reconstruct our evolutionary past.

Other explanations for the origin of modern human behavior hypothesize that some radical social or demographic event sparked a behavioral revolution about 50,000 years ago. These explanations, however, are at least as circular as the neurological hypothesis, because the evidence for the social or demographic change is simply the behavioral revolution they are meant to explain. And they offer no reason for why the momentous social or demographic change failed to occur tens of thousands of years earlier. Nominating a genetic mutation as the cause answers the "why" question. Mutations arise all the time in individuals and populations. Some are harmful, even lethal; most are neutral, conferring neither benefit nor burden. But a few give their possessors an advantage that, however slight, improves their odds in the game of evolution. If this advantage aids in the ability to obtain or process food, to acquire a mate, and to raise offspring to reproductive age, it is likely to spread within a population. The greater the advantage the mutation confers, the more rapidly it will spread, and no one could question the advantage of a mutation that promoted the fully modern brain. By enhancing the brain's cognitive and communicative capacity, it would have allowed humanity's external and internal journeys of discovery that continue to this day.

Fossil, archeological, genetic, and linguistic evidence all point to Africa as the place where the 50,000-year-old behavioral break-

through occurred. And based on what we know at the moment, only eastern Africa harbored substantial human populations in the interval surrounding 50,000 years ago. Elsewhere in Africa, severe aridity appears to have sharply reduced human populations from 60,000 years ago or before until 30,000 years ago or later. Thus, only east African sites like Enkapune Ya Muto may record the dawn of human culture. The more certain point, however, is that the dawn did not occur in Europe. Although our concept of early symbolism is inevitably skewed by resplendent European examples like the charcoal rhinoceroses and bears on the walls of Grotte Chauvet or the multicolored bulls and horses of Lascaux, these all postdate the emergence of modern behavior and the arrival in Europe of fully modern humans. Had the crucial mutation occurred first in Europe, the earliest evidence for modern behavior would be there, and students of human evolution today would be Neanderthals marveling at the peculiar people who used to live in Africa and then abruptly disappeared.

Culture provides a uniquely advantageous means for adapting to environmental change. Cultural innovations can accumulate far more rapidly than genetic mutations, and good ideas can spread horizontally across populations as well as vertically between generations. This strategy of cultural adaptation, more than anything else, has enabled our species to transform itself from a relatively insignificant large African mammal to the dominant life form on Earth. We have developed an unprecedented ability to adapt to a wide variety of environments and, sometimes unfortunately, to alter them irrevocably. Having acquired this seminal cultural advantage, the earliest fully modern humans were able to disperse from Africa, northwards through the Near East to Europe and eastwards across Asia to China and

beyond. Because people could now obtain more resources to produce and feed yet more people, population numbers began their long, steep climb to the levels that we now enjoy. Humans colonized new and increasingly challenging environments and began to develop the forms of complex social organization that are both a blessing and a curse today. And the rest, as they say, is history.