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Humankind in Prehistory: Economy, Ecology, and Institutions

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This essay is about who we were in prehistory and how we were shaped by economic principles.[1] Of the many models that one encounters in the antiquities literature of humankind, unabashedly economic models are rare. Such models are easily dismissed as reductionist economic determinism because they appear not to account for the richness of culture. The tale of humankind I relate here is based on a relatively simple model of the influence of opportunity cost and human capital accumulation. It explains mankind's evolution from our genesis in bipedalism through tool manufacturing to anatomically modern *Homo sapiens*, hunting big game, planting seeds and harvesting crops, and developing art and language.

Crucial to this development and consistent with the theme of this volume,

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prehistoric man developed institutions that conditioned his use of resources. Property rights evolved as an essential part of man's institutional environment as a result of the changing constraints of the natural and technological environment. These property rights could evolve in the absence of a centralized state because they depended on reciprocity, mutual dependence, and state-like forms of control achieved through broadened kinship ties, customs, and culture. While early property rights were not always private or transferable, they did constrain individual and group behavior by limiting access to scarce resources. In this sense, the successful evolution of humankind is closely related to the customs and culture that shaped prehistoric property rights.

Life Emerged Early, Bipedalism and *Homo* Very Late

The Earth and other planets, formed by the condensation of gas that produced our solar system, are about 4.5 billion years old. Elementary life forms, found in Australia and South Africa, appear 3.8–3.5 billion years before present (B.P.), which is about as early as life as we know it could have emerged. But multicellular animals are not found in the fossil record until much later, some 650 million years B.P., and those of modern form that are believed to be antecedents of humankind appear about 550 million years B.P.

In Africa, sometime between 10 and 5 million years ago, bipedal protohumans almost certainly split off from the forerunners of today's chimpanzee and gorilla. This is indicated directly by the fossil record and by genetic comparisons between living people and other primates. During this period a globally cooler and drier climate shrunk forests in favor of grasslands and savannas (Klein 1989, 29–35, 180–181; Laporte and Zihlman 1983). This was a conditioning factor. Grassland ungulates (hoofed mammals) increased in number and diversity as the cost of harvesting their food declined, and the resulting economic stress on forest dwellers brought the extinction of many ape species in Eurasia. But at least one ape species in Africa adapted by becoming more of a ground dweller (Klein 1989, 181). These environmental changes may have made bipedalism an economizing response in several ways: it was easier to carry food and young; heat stress would have been reduced by exposing less body surface to direct sunlight; the freeing of hands for using, carrying, and later fabricating, tools; the decreased energy requirements of locomotion; and, finally, improved ability to see over obstructions, grass and shrubs.

Although bipedalism predates the earliest recorded stone tools, early humankind may have used wood, bamboo, and other perishable material for simple fabricated tools, much as Chimpanzees (genetically the nearest relative of humans) will make, transport and use sticks to reach for food.[2] In fact it can be argued that an elementary reliance on implements may have predated bipedalism and helped to account for our protohuman ancestor's ability to flourish in Savanna environments (Laporte and Zihlman 1983, 105–7).

Although bipedalism was the important opportunistic response (for us), it was not a unique experimental adaptation by nature to the demands of a Savanna environment. Apparently the other response was to become a more effective quadrupedal knuckle-walker, to evolve into the modern chimpanzee, and to continue to exploit woodland as well as Savanna environments (Zihlman 1991). If our ancestral protohumans were adaptively attempting bipedalism as grasslands expanded, then mutations favoring bipedalism would have economic value.

At some point, perhaps 4–3 million years B.P. (proposed in Zihlman and Cohn 1988), early bipedal hominids developed reduced body hair and thermo-regulatory (body cooling) sweat glands. Hair reduction would have necessitated skin pigmentation to protect against ultraviolet radiation. These developments, especially in combination with bipedalism, would have greatly enhanced survival and foraging productivity in open grassland and savanna mosaic environments.

The cooler dryer trend in climate that is associated with the emergence of bipedalism accelerated from 2.5 to 2 million years B.P. This coincided with rapid evolutionary change in hominids and other African mammals leading to a more carnivorous, larger-brained, and more tool-dependent lineage of *Homo* whose expanding niche may explain the decline of other African carnivores (Vrba 1985; Walker 1984).

The earliest firmly documented stone tools (attributed to *H. habilis*) are found at the Hadar site in Northeast Ethiopia adjacent to the Red Sea; they are conservatively dated at 2.5–2.4 million years B.P., but could be as old as 3.1 million years (Harris 1983). These and other sites in Zaire, Olduvai and elsewhere show that stone tools were widely used in Southern and Eastern Africa by 2 million years B.P. These early tools, while crude by later standards, were diverse, but the diversity (based upon experimental replication) appears to have been controlled by the random shape of the original blank not by deliberate design (Toth 1985). The tool kit and their suggested uses included flakes (for cutting and splitting), scrapers (for butchery), and cobble missiles (for hunting or defense). The combination of such stone tools with fragmentary animal bones clearly demonstrate an increased interest in meat by *H. habilis* over earlier hominids; but it cannot be definitely said that they were great hunters. Most of the assemblages are found near ancient stream or lake beds where animals would have congregated. Although the bones often show evidence of scarring from stone tools this does not prove that meat was obtained by hunting instead of by scavenging the kills of other camivores. Whether it was more cost efficient for these early humans to take meat from such formidable carnivores than to dispatch the prey themselves is an open research issue. A recent study of Hazda scavenging finds that "scavenging returns were highly variable, depending on carcass encounter rates, carcass size and completeness on encounter, and success at displacing the original predators" (O'Connell, Hawkes, and Jones 1988, 356). The authors conclude that even if early hominids had no difficulty displacing competing carnivores, scavenging could only have been intermittently successful in savanna environments comparable to those in the Hazda study.

At the beginning of the Pleistocene, approximately 1.8–1.7 million years ago, *H. habilis* was replaced by *H. erectus*, generally thought to be the direct ancestor of *H. sapiens* and of you and me. Today we are still in the Pleistocene epoch (or Quaternary) enjoying a warming interglacial period which began about 14,000 years B.P.[3]

The significance of the Pleistocene is that the evolutionary, cultural and economic development of humankind was accelerated during the ebb and flow of the earth's cycles in glaciation. There have been 17 major glaciations in the last 1.7 million years and eight during the last 730,000 years. At the peak glaciation nearly a third of the earth's surface was covered by ice sheets; and the sea level dropped by 400–500 feet. This caused the joining of land masses that were isolated in the warm stages: Siberia with Alaska, Australia with New Guinea and Southeast Asia with Java. Gulfs such as the Persian were river valleys above sea level. Within the past 1 million years interglaciations as warm as the one we are now experiencing have lasted only about 10,000 years whereas the periods of glaciation have lasted more like 100,000 years. (Perhaps this will comfort those concerned with global warming.) Consequently, our ancestral development occurred under mostly glacial conditions, to which we adapted well. These cycles of glaciation made possible a world-wide redistribution of plants, animals, and humankind (Klein 1989, 34–35).

Out of Africa: Exodus I

A prominent contemporary view of the emergence of modern humans is the "out-of-Africa model" in which humankind first evolved in Africa then spread throughout Eurasia (Gould 1988; Stringer 1990) in an initial wave beginning about 1 million years B.P. In Africa the displacement of *H. habilis* by *H. erectus* may be explained by the increased emphasis on tool use and by carnivory. *H. erectus* was much better endowed with a locomotor skeleton, had a larger brain plus the typically human external nose.[4] These endowments suggest improved exertion capacity and hunting, gathering, or scavenging skill.

The greater adaptability of *H. erectus* is demonstrated by this people's colonization of previously unoccupied dry regions of Africa about 1.5 million years B.P. and by their dispersal to Northern Africa and thence into colder regions such as Eurasia and China, and to Java after 1 million years B.P. Generally, in the African and eastward expansion paths of *H. erectus* one finds evidence of tool use which required more investment in human capital—planning, foresight, and preparation effort—than is associated with *H. habilis*. Thus the finding that most of our current growth is due to investment in human capital probably applies with even greater force to the last 2 million years of hominid development. The tool kit now includes hand axes, cleavers and other large bifacial tools used for butchery, bone breaking and perhaps wood working (wood spears appear toward the end of this period). Also it is likely that *H. erectus* could control the use of fire; the oldest evidence is 1.5 to

1.4 million years B.P., although more convincing evidence does not appear until 500,000 years ago[5].

A long standing puzzle is the geographical distribution of these tools in Southeast Asia; here the tools are less standardized and there is a paucity of hand axes but no shortage of chopper tools. At one time this led to the conclusion that *H. erectus* was culturally retarded, that they had minimal capacity for standardizing the manufacture of stone tools. Yet it is hard to believe that the same race of people who made hand axes in Africa and Northwest Asia, and who had trekked to Southeast Asia had unintentionally lost this sophisticated craft. A hypothesized solution has now been offered by the observation that the line across Southeast Asia below which one finds alleged "cultural retardation" corresponds to the distribution of naturally occurring bamboo. This is an area which today contains over 1000 species of bamboo, a raw material that can be fabricated into knives, spears, projectile points, and traps (Pope 1989). It would appear that *H. erectus*, far from having suffered cultural degeneration in bambooland, was simply responding to the locally high opportunity cost of making standardized tools, such as hand axes, from stone.

Out of Africa: Exodus II

Up to about 500–400,000 years B.P., most human fossils are those of *H. erectus* in Java, China and Africa. The exceptions are assigned to early *H. sapiens*. The European fossils suggest an anticipation of the later Neanderthals. The trend was different in Africa where *H. erectus* appears to have evolved in the direction of modern *H. sapiens*, while fossils in Southeast Asia maintained their similarity with *H. erectus*. Artifacts in the latter region continue to be dominated by flake and chopping tools with an absence of hand axes. Early *H. sapiens'* hand axes and other stone artifacts were better made, and they invented a technique for predetermining flake size so that tools could be more deliberately designed, but such artifacts were generally uniform in function and style over wide areas and a long period of time (Klein 1989).

Neanderthals—traditionally believed to be our immediate ancestors—are thought to be a Eurasian descendant of *H. erectus*. They appeared 130,000 years ago or earlier, had a brain case at least as large as living people, and, judging from the skeleton and muscle/ligament markings on the bones, had exceptional physical strength (Trinkaus 1986). They were adapted to cold climate, and made tools of wood (e.g. spears), but bone tools are rare. Judging from the animal bones at numerous sites, Neanderthals successfully hunted deer, bison, aurochs (wild cattle), sheep, goats and horses. They cared for family members who were handicapped or incapacitated, and were the first people who practiced intentional burial, perhaps with ceremony; they may have adorned their bodies with ocher. But their unusual adaptation was not viable, and they disappeared about 30,000 years ago (Klein 1989; Gould 1988).

Although modern *H. sapiens* or Cro-Magnons traditionally had been thought to originate 50–40,000 years B.P., and to have overlapped Neanderthals, recent claims find anatomically modern humans as early as 90,000 years B.P. (Valladas et al. 1988). Thus Neanderthals may have overlapped Cro-Magnons for over 50,000 years, and according to one view, are not central stock but a side branch. The contemporary view, supported by fossil and genetic evidence, is that modern humans evolved within the period 200,000–50,000 years B.P. in Africa.[6]

Prior to this, time body form and behavior (based on tool assemblages) evolved together (Klein 1989, 1992). Subsequently, behavioral evolution accelerated, within a constant bodily form. Thus, "The people of Cro-Magnon carved intricate figures of horses and deer and painted their caves with an esthetic power never exceeded in the history of human art" (Gould 1988, 16). After 40–35,000 years ago artifact assemblages varied tremendously across neighboring regions, and the pace of change accelerated dramatically (Klein 1989, 360–398). Cro-Magnons fashioned bone, ivory and antler into projectile points, awls, punches, needles and art objects. Compared to the Neanderthal, their stone crafts included more blades with longer cutting edges and numerous shouldered projectile points of the kind suitable for spears, arrows and darts. Also graves, houses and fireplaces were more elaborate. Ceramic fired clay appears about 28,000 years B.P.

Eurasian Cro-Magnons hunted in savannas and grasslands principally for mammoth, bison, reindeer, antelope and horse—all large gregarious herbivores—that provided meat, hide, and sinew, as well as bone, antler and ivory. Like the American Indian and the plains settlers, it is likely that they burned the dried droppings ("buffalo chips") of large animals where wood was unavailable (Klein 1989, 366). After 20,000 years B.P. the artifacts include the atlatl (spear thrower), arrows, stone inserts in antlers, harpoons, leisters (three pronged fish spear), eyed needles, and all manner of clothing—jackets, shirts, trousers, etc. Conclusive evidence for the bow and arrow appears 12–10,000 years ago (Tyldesley and Bahn 1983), but a much earlier origin is likely given the frequent occurrence of stone points similar to those used for arrow tips in historical times.

In Europe 34,000–11,000 years B.P., there is widespread evidence that humankind had the means of making large numbers of kills of a single species. They ate ungulates, fish, molluscs, birds and seals. The staples were reindeer, red deer, horse, ibex and bison. Evidence of the mass slaughter of horse and reindeer suggest they were driven into cliff enclosed canyons, or off "jumps." The Cro-Magnons were adept at the battue (beating underbrush to drive game), the drive line, the stampede, and the pit trap.

Humankind: Super Predation and World Expansion

Modern *H. sapiens* spread from Africa through Europe and Asia in the last 50,000 years, jumped to Australia by about 40,000 years B.P., entered Alaska perhaps 14–12,000 B.P., the lower 48 states of North American by 12,000 B.P., and within

the next 1000 years reached the southern tip of South America. The last stages of this worldwide expansion were Madagascar, New Zealand, and Antarctica which were occupied by humankind only in the last 1000 years.

A plausible theoretical hypothesis is that North America was discovered by advanced Paleolithic people who crossed the exposed Bering land bridge, connecting Asia with Alaska, 14–12,000 years ago. The Bering terrain was unsuitable for gathering plants but the subarctic grasses supported the cold-adapted mammoth, bison, and caribou. Communal hunting parties, armed with stone weapons, and able to control fire, were big-game hunters par excellence. Their descendants found an exposed land corridor between the Western and Midcontinent ice sheets in Canada (Klein 1989, 390) and made their way ultimately into Montana, then South and East throughout the United States. As suggested by Martin (1990), they entered a continent that was an unprecedented "home-on-the-range" for now extinct mammoth, mastodon, ground sloth, two species of extinct bear, a cheetah, the giant beaver (*Castoroides*, the size of a black bear, and the largest North American rodent), horse, tapir, two species of peccary, camel, llama, two species of extinct deer, the stag moose, pronghorn, shrub ox, two species of musk ox, yak, two subspecies of bison (*B. occidentalis* and *B. antiquus*), both larger than the surviving *B. bison* known to the plains settlers, the dire wolf, a saber-toothed and a scimitar-toothed "tiger," and many other less familiar megafauna. Many of these animals, such as the ground sloth, were slow and would have been easily hunted, or like the mammoth, mastodon, and horse were large gregarious herding animals. The herding behavior of these great animals implied low search cost for hunting parties armed with stone projectile points and strategic knowledge of animal behavior; their great size meant high value per kill; while some prey such as the extinct plains bison may have been easier to hunt than their living relatives. Since there were no property rights in live animals, only in harvested animals, there was no incentive to stay the spear in anticipation of tomorrow's reproductive value as with modern domesticated cattle—descendants of the Old World auroch. The resulting mass harvesting pressure on animals may have caused or contributed to the extensive megafauna loss on the North American continent by 11,000 years B.P. Their hunting parties left behind Clovis fluted points—a work of craftsmanship in stone—found from Florida to Nova Scotia, in the high plains, the Southwest, across the Midwest, and in the South. These points are 7–15 centimeters long, 3–4 centimeters wide with concave bases, and a fluting extending from the base to one-half the length of the point. They were flaked by percussion and the base edges ground down to prevent cutting of the thongs securing them to a throwing or thrusting spear—a design that would allow the weapon to sustain lateral stress if it remained in the hand of the hunter after penetrating the prey.

That Clovis hunters killed mammoth is well documented; also that these animals had become extinct by 11,000 years B.P. (Haynes 1964, 1988), although they " . . . had been in North America for over one million years" (Martin 1990, 111). Numerous mammoth kill sites in the western United States show direct evidence that

the mammoth was harvested by hunters. Some sites also contain the bones of camel and horse,[7] but no incontrovertible evidence exists that these animals were hunted in North America, although the horse was one of the most widely hunted animals in the Paleolithic Old World. The horse became extinct in North America (where it originated) only about 10–9000 years B.P. (Mead and Meltzer 1984, 446). It was reintroduced by the Spanish in the sixteenth century and has thrived in the wild down to the present under the arid conditions of Arizona, Nevada and Utah. The Clovis point was replaced by the Folsom point between 11,000 and 10,000 years B.P.; it is less widely dispersed than the Clovis and is associated with the extinct *Bison antiquus*, which is much larger than surviving American Bison. The Scottsbluff and similar projectile points date from about 9000 years ago and are associated with the slightly smaller extinct *Bison occidentalis*. It appears likely that Paleo-Indian procurement of Bison occurred in mass kills, sometimes of several hundred animals at a time. This is illustrated at the Olsen-Chubbuck site in Colorado (Wheat 1967) where, 8500 years B.P., 200 *B. occidentalis* were stampeded into an arroyo 5–7 feet deep, and dispatched with Scottsbluff projectile points. At least 50 of the animals apparently represented a wastage kill since they showed no evidence of butchery for consumption. Dozens of such kill-butchery sites are found in Colorado, Wyoming, Montana and Nebraska (Frison 1986; Todd 1986). Many sites are stampede jumps or traps, with several thousand years of use. Perhaps the species survived in the form of the plains bison by dwarfing (Edwards 1967); indeed this could have been an adaptive response to the greater vulnerability of the larger subspecies to predation.[8] In any case despite the enormous carrying capacity of the land from Alberta to Texas, which in historical times supported perhaps 60 million bison, we were left with far fewer large species than the fossil record of the Pleistocene would lead one to expect.

Martin (1968, 1984, 1990) has summarized the evidence for the world-wide extinction of late Pleistocene megafauna. In Africa and Asia 15–20 percent of the genera disappeared 80–60,000 years B.P.; in Australia 94 percent were lost from 40–15,000 years B.P.; North and South America experienced a 70–80 percent loss in the last 15,000 years, with an abrupt North American loss of mammoth, mastodon, ground sloth, and such dependent predators and scavengers as the saber toothed cat and (in much of its range) the condor 11,000 years ago. The horse and two subspecies of bison were gone by 9–8,000 years ago. This worldwide pattern correlates suspiciously with the chronology of human colonization leading to Paul Martin's hypothesis that extinction was directly or indirectly due to "overkill" by exceptionally competent hunter cultures. This model explains the light extinctions in Africa and Asia where modern humankind "grew up," allowing gradual adaptation to humankind's accumulating proficiency as a superpredator; it explains the abrupt massive losses in Australia and the Americas—the only habitable continents that were colonized suddenly by advanced stone-aged humans. But the control cases for Martin's "experiment" are the large oceanic islands such as Madagascar and New Zealand; both were colonized within the last 1000 years, and both suffered a wave of extinctions at this time (Dewar 1984; Trotter and McCulloch 1984; Anderson

1989).[9] One wonders, if extinction was due to climatic change, why Madagascar extinctions were not coincident with those of Africa 220 miles off its coast, and those of Australia were not coincident with New Zealand extinctions; and why European and Ukrainian mammoths became extinct 13,000 years B.P. while in North America they survived another 2000 years. Previous great extinction waves had affected plants and small animals as well as large animals, but the late Pleistocene extinctions are concentrated on the large gregarious herding, or slow moving, animals—the ideal prey of human hunters. Such large genera are also the animals that are slower growing, have longer gestation periods, require longer periods of maternal care, and live longer. Consequently they were more vulnerable to hunting pressure because reductions in biomass require more time to recover. The theory is bold—some say fanciful. A counter argument is that there is little direct evidence of hunting; that Paleolithic peoples "probably" relied on plants. But if the fossil record of hunting is "small," the fossil evidence of gathering is virtually non-existent (Klein 1989, 219, 364–5).

A second counter argument is that there would not have been an incentive to overproduce in excess of immediate needs; that this occurs only in modern exchange economies (Frison 1986, 213). But this argument fails to recognize that in the absence of private property rights, there is no intertemporal incentive to avoid the kind of waste associated with large kills. What controls the slaughter of domestic cattle is the comparative value of dressed versus live beef (Smith 1975, 745). Since no one owned the mammoth, their harvest value (net of hunting cost) contrasted sharply with their zero live procreation value to the individual hunter. A third argument finds it incomprehensible that mere bands of men could have wiped out the great mammoth and two subspecies of bison.[10] It takes a particularly skilled modern rifleman to stop a charging African elephant in time to prevent injury, and extant bison react quickly and violently when they sense danger (Frison 1986, 188–192).

Such observations may simply tell us that these particular subspecies have survived because they were selected for their successful defensive characteristics. We know nothing of the behavioral properties of extinct species which may have been far more approachable than their surviving relatives. While the African and Indian elephants are both members of the same genus, their fossil similarities fail to inform us that the Indian elephant is docile and easily trained for circus display, while the African elephant is not. No one has successfully domesticated the African zebra; in contrast, the Tarpan horse has been domesticated since ancient times (5000–2500 B.P.). *Equus* includes horses, asses and zebras—all behaviorally distinct animals.

Interpretations and Hypotheses From the Prehistoric Record

Several principles and hypotheses stem from an economic interpretation of this brief survey of the prehistorical record.

1. *Hunting and gathering provided the technology and institutions for the first affluent society.*

One of the great myths of modern humankind is the belief that life in the Paleolithic was intolerably harsh, or as presumed (without evidence) by Hobbes, "solitary, poor, nasty, brutish and short." It may have been none of these. What is just as likely is that hunting and gathering provided the first affluent society (Sahlins 1972); it sustained and promoted humankind for almost all of their 2.5 million years of existence. The Hobbesian belief obscures the striking continuity in the ability of prehistoric humans to adapt to changes in their environment by substituting new inputs of capital, labor and knowledge for old, and to fabricate new products when effort prices were altered by the environment, or by new learning. Late Pleistocene human skeletons show a mortality pattern like that of historic hunter-gatherers, and "rarely show evidence of serious accidents or disease . . ." (Klein 1989, 385). Their teeth were healthy probably because their diets contained little sugar. Historically, among the hunting and fishing peoples of Africa, Australia, the Pacific Northwest, Alaska, Malaya, and Canada, malnutrition, starvation, and chronic diseases were rare or infrequent. Studies of the African Kung Bushman (Lee 1968) show that these people worked only 12–19 hours per week; their hunting and gathering activities scored well on several measures of nutritional adequacy; and their labor bought much leisure in the form of resting, visiting, entertaining and trance dancing.[11] Similarly, African Hazda hunters worked no more than two hours per day, with time for gambling, other social activities, or investment. Much of the diversity in our ancestral development must have been due to the extent to which different peoples employed released time from subsistence for different forms of investment in human capital.

Although studies of the prehistoric record place great emphasis on the intellectual development of humans—brain size, tool use, the control of fire—their prowess as hunter-gatherers was likely also due to their physical superiority over other animals. After all, tool development was slow and limited until the explosive development of the late prehistoric period. But human physical superiority is striking. As J. B. S. Haldane once noted, only man can swim a mile, walk twenty and then climb a tree.

2. *Opportunity cost has conditioned the cultural and economic development of humankind.*

This principle was articulated succinctly by the Kung bushman who was asked by an anthropologist why he had not turned to agriculture (as his neighbors had done). His reply: "Why should we plant when there are so many mongongo nuts in the world?" (Lee 1968, 33). Why indeed, unless tastes and opportunity cost combine to demand it? Bipedalism itself occurred at a time when the cost of an arboreal existence was stressing primate populations. An economical adaptation was to subsist in the spreading savannas and grasslands that were replacing the forest. The

great migrations out of Africa, the invention of weapons for big game hunting, Eskimo adaptation to hunting sea mammals, humankind's eventual turn to agriculture; these can all be interpreted as responses to changes in opportunity cost whether driven by environmental change, by human learning, or their conjunction. A telling example of the influence of effort prices on prehistoric human choice is found in Lee's (1968) study of 58 extant hunter-gatherer societies the world over. There is a strong correlation between a society's distance from the equator and the relative importance of hunting over gathering in its diet. In the Arctic the hunting of land and sea-mammals predominated, while in the temperate latitudes up to 39 degrees from the equator, gathering was much the more important economic activity.

Economic models of human development and change are often held suspect because they appear not to account for the richness of culture. But culture and institutions can be interpreted as providing the information system for transmitting the learning embodied in the unconscious response to opportunity cost and as providing the rules of the game that prevent the "tragedy of the commons." Thus hunter cultures use ceremony and ritual to enhance recognition of the value and significance of the chase and its technology of execution. Culture is the means of transmitting human capital from generation to generation; of forming in the young an indelible impression of the hunt. The magnificent Cro-Magnon art preserved on the walls deep in the narrow crawl spaces of French and Spanish caves have been given this interpretation: "Imprinting enormous amounts of information in memory called for . . . the use of confined spaces, obstacles and difficult routes, and hidden images to heighten the natural strangeness of underground settings . . . piling special effect on special effect in an effort to ensure the preservation and transmission of the tribal encyclopedia" (Pfeiffer 1982, 132).

Another example of the hidden economic function of culture is the magical practice of the Naskapi Indians of Labrador, who, when the caribou were scarce and the tribe hungry, resorted to scapulimacy, a divination in which the shoulder blade bone of a caribou was heated by fire until it cracked. As cracks appeared, they were interpreted by a diviner in terms of the local geography and caribou haunts, as trails, one of which the hunter should follow if he was to be successful. Speck (1935) reports having observed 12 successful hunts out of 19 divinations, noting that the unsuccessful cases were always attributed to the failure of the diviner to correctly read the scapula map. All this is interpreted by Speck as showing the capacity of the Naskapi for belief in magic. But is scapulimacy functional? One function of course is to sharpen the hunter's concentration, and to impress upon all the need for great dedication. Moore's (1957) study of magical practices led him to the conclusion that they served immediately practical economic ends. The effect of Naskapi magic was to cause the hunter to choose a random route, steering him away from previously successful hunting routes, and preventing the caribou from being sensitized to regularities in hunter behavior.[12] What the Naskapi in effect seem to have discovered was that reading shoulder blades had survival value. "People are capable of formulating any number of strange ideas, not necessarily directed towards any

particular end, but if they do have a practical application and are successful, they may persist. And if they persist long enough people will begin to believe in them" (Reader 1988, 139). If they are believed, I might add, they will be incorporated into educational rituals so that the tribal learning is not lost to each new generation.

3. *Prehistoric H. sapiens accumulated human capital.*

Economic success as a hunter-gatherer required an endowment of human capital normally associated only with the agricultural and industrial revolutions: learning, knowledge transfer, tool fabrication skill and design, and social organization. The aboriginal use of fire for game and plant management demonstrates that prehistoric humans possessed knowledge of the phenology of trees, shrubs, and herbs, used fire to enhance the growth and flowering of certain food plants (huckleberry and hazel bushes, bear lilies, wild rice, etc.), and to suppress the growth of competitors.[13] Effective game and wild plant management required people to know where, when, how and with what frequency to burn. Aboriginals knew that the growing season for wild plants can be advanced by spring burns designed to warm the earth, that in dry weather fires should be ignited at the top of hills to prevent wild fires,[14] but in damp conditions they should be set in depressions to avoid being extinguished, that the burning of underbrush aided the production of acorns by the oak trees, and attracted moose, deer and other animals who feed on the tender new shoots that follow a burn.[15]

Humankind was a fire creature beginning with *H. erectus*, and fire "revolutionized human society and its relationship to the natural world" (Pyne 1991). Anthropogenic fire redefined or reformed food, dentition, facial muscles, tools (wood spears could be fire-hardened, trunks fire-carved into dugout canoes) and the ecology of humankind's environments. The Australian aborigines were the "black lightening" that ignited Australia with their arrival some 40,000 years ago where they lived abundantly by fire stick farming: burning to increase access to roots and tubers, to recycle nutrients more quickly in dry regions, and to increase grass and plant yield; to flush or kill game; to increase plant food for a new cycle of game production.

The life of a hunter-gatherer is one of commitment to an intellectually and physically demanding activity requiring skill, technology, social organization, division of labor, knowledge of plant and animal behavior, of climate, seasons, and winds, the habit of close observation, inventiveness, problem solving, risk bearing and high motivation. These demands would have been selective in humankind's cultural and biological evolution, and helped to develop the human capital and genetic equipment needed to create modern civilization. The aboriginal practice of awarding more wives to the most successful hunters would have favored the genetic selection of these traits.[16]

It was as a hunter-gatherer that humankind learned to learn: young hunters needed to be imbued with knowledge of animal behavior and anatomy, with the habit of goal-oriented observation, to learn that ungulates often travel in an arc so that success

could be increased by traversing the chord, and so on. Knowledge of animal behavior could substitute for weapon development. From knowledge of animal anatomy it was but a short step to curiosity about human anatomy, the discovery that we are one with the animals, and to the first practice of medicine.

4. ***Property rights are likely of ancient origin.***

Although humankind have made stone tools for at least 2.5 million years, the archeological record of property rights is more obscure. Nonetheless, the similarities between the cultural materials of late-Pleistocene and aboriginal peoples suggest that such social traditions originated at least as early as the period 40,000–20,000 years B.P. Cultural materials (amber, sea shells, stone tools) often occur hundreds of kilometers from their points of origin indicating intergroup contacts over wide areas (Klein 1989, 376–8). No such evidence of social contact occurs before the late-Pleistocene, when the archeological record shows a vast increase in property: bows and arrows, atlatls, seed grinding stones, boiling and storage vessels, kilns for firing clay, boats, houses, villages, animal drawn sledges, the domesticated wolf. New tools and techniques allowed new products of gathering and hunting to substitute for the loss of big game. Previously, gathering emphasized the seeds and plants that could be eaten while on the move. Now the seeds gathered were inedible without soaking, grinding and boiling. This upsurge in personal paraphernalia implies more sedentary, less nomadic, hunting and gathering. Knowledge of the seasonal cycles of plants and animals, of the use of fire in resource management, of techniques of storing, drying and preserving foods, all combine to make life more sedentary. But with the accumulation of personal property and real estate would come more complex property right and contracting arrangements.[17] Dalton (1977) has summarized the economic, but also the important political function, of the ceremonial exchanges of Northwest America and Melanesia, such as the potlatch, kula, moka and abutu, which in substance are elaborate multilateral contracting mechanisms. The valuables exchanged (bracelets, pearl shells, cowries, young women) bought not only other commodities in ordinary exchange; they bought kinship ties with the exchange of daughters, military assistance if attacked, the right of refuge if homes and property had to be abandoned, and emergency assistance in the event of poor harvest, hunting or fishing. They bought political stability in stateless societies, and a property right environment that facilitated specialization and ordinary exchange. Property rights thus precede the state and property included private goods such as land, fishing sites, livestock, and cemetery plots, but also public goods such as crests, names, dances, rituals and trade routes that could be assigned to more than one individual or group.

How is it possible that property rights and exchange could exist prior to the advent of the state and of central enforcement? The answer is to be found in reciprocity, mutual dependence, and state-like forms of control achieved through broadened kinship ties and the outright purchase of political stability. If I grow beans and you grow corn, and we exchange our surpluses, we each have a stake in

protecting our respective property rights. If either of us plays the game of `steal' rather than the game of `trade' this will end our prospect of maintaining a trading relationship tomorrow. Once humankind opted for less nomadic forms of hunting and gathering, such reciprocal relationships would have been vastly more important. Transients always, and even today, pose a more demanding problem of property right enforcement, than those who are in more permanent contact with each other.[18] The conditions of reciprocity would have been powerfully present once the agricultural revolution came, but I suggest that they already existed in hunter-gatherer communities that were managing and harvesting from relatively fixed resource bases. Moreover, stateless societies did not have to rely entirely on voluntary forbearance based on the incentive support from reciprocal relationships. They also purchased political stability by paying tribute and by kinship exchange and "gift-exchange."[19]

Evidence for the existence of property rights and social contracting in stateless societies is incontrovertible. Heizer (1955) notes that in North America the private ownership of fishing and hunting grounds, nut trees, and seed gathering areas was common. Among the Karok (Kroeber and Barrett 1960), owning the right to fish a particular eddy or channel of a river was independent of who owned the land along the river, and the right was transferable by bequest or sale. Similarly, an individual would own sealing rights to a particular coastal rock. Peter Freuchen (1961), who lived with the Greenland Eskimos at the turn of the last century, describes the social organization and trading behavior of these prehistoric hunting-fishing people. Among their social contracts was a simple incentive compatible rule for allocating the skin among hunting team members when the prey was the dangerous polar bear: "The hunter who fixed his spear first in the bear gets the upper part. That is the finest part, for it includes the forelegs with the long mane hairs that are so much desired to border women's kamiks (boots) with" (Freuchen 1961, 53).

5. *Humankind was an intense user of the environment for self-interested ends.*

Although today we associate environmental damage, including extinction, with the advent of industrial society and human population growth, it is likely that prehistoric humans had a comparable, or perhaps more severe impact, on their environment. This is because the species that have survived to the present represent the less vulnerable plants and animals. If Paul Martin is correct, that the wave of animal extinctions beginning with the "invasion" of Australia 40,000 years B.P. and ending with the occupation of Madagascar and New Zealand, were of anthropogenic origin, then the losses were of species that had inadequate defensive capabilities. The winnowing left the more stubbornly resistant species, able to survive all but major destructions of habitat. Major losses of hunted game animals in the prehistoric period can also help to account for the enculturation of self-serving conservationist principles in the myths, rituals and beliefs of aboriginal societies. Thus the Choctaw had rules regulating the game that could be killed by one family. The Kaska trapped marten in a game area only every two or three years. The Iroquois and many other

tribes spared the females of hunted species during the breeding season. The Yurok had "game laws" the violation of which would cause loss of "hunting luck." Many tribes believed that game is watched over by supernatural deities who are angered if too many animals are killed or if they are merely wounded.[20] Thus tribal property rights, though not always private and transferable, encouraged resource stewardship.

A second source of ecological change induced by prehistorical peoples was their transportation of seeds in hunter-gatherer migrations throughout the world. The introduction of botanical exotics into new regions has often been noted by archaeologists who have observed the association of various plants with campsites and dwellings; the wide distribution of wild squash appears to be associated with humankind. Other plants whose patterns of incidence suggest that they were spread by early humans include mulberry, black walnut and buckeye trees, elderberry, nettle, scurvy grass, sweet flag, crabapple, cactus, and lotus (Heizer 1955, 12–13).

Finally, the human use of fire is thought to have had a profound effect on the ecology of the environment. Many authors who have studied patterns of land burning by primitive peoples have concluded that many of the world's great grasslands were produced by periodic burning (Heizer 1955, 9–12; Lewis 1980). Where tree growth is favored by weather conditions, periodic burning will select for particular species such as the pine forests in southern New York, and to the West, which have been attributed to Indian burning. Similarly, the disappearing grassland areas in northern Alberta are attributed to Canadian restrictions on traditional Indian burning (Lewis 1980, 76–77).[21]

6. *Long plateaus without change are punctuated with revolutionary leaps in biological and economic development.*

There were essentially three prehistoric revolutions in the development of mankind, prior to the agricultural revolution: bipedalism, the invention and development of tools, including fire, and the explosive accumulation of human capital by Cro-Magnon peoples. As I have already argued, bipedalism, which became adaptive somewhere in the period 10 to 5 million years ago, was probably a bioeconomic response to the cooler, dryer climate that reduced the proportion of forested lands in Africa. Then sometime between 5 and 3 million years ago our protohuman ancestors discovered the value of stone tools so that by 2.5 million years B.P. they are being fabricated by *H. habilis*. From the stone tool breakthrough down to about 40–30,000 years B.P., the record shows discrete improvement in tool use and fabrication (including fire) as *H. erectus* displaces *H. habilis*, followed by early *H. sapien*; then the Neanderthals arrive, make their indelible mark, but disappear some 30,000 years ago. The Cro-Magnon people produced an astonishing creative outburst—in tools, art and hunting-gathering techniques—beginning sometime after 40,000 years B.P. (Pfeiffer 1982). This great acceleration in human capital formation, and Cro-Magnon's rapid spread throughout all the major continents, set the stage for the agricultural revolution. It did this partly by giving our immediate ancestors the

knowledge of animals and seeds required by the agricultural way of life, but probably also by hastening the demise of the megafauna that were the favored game of the chase, and thus tipping the opportunity cost balance in favor of tilling the soil.

What accounts for the sudden acceleration of human economic and cultural development after 40,000 years B.P? Cro-Magnon people had already been firmly established in Africa for perhaps 60,000 years, and had already begun their spread throughout the world. I believe the most likely cause is the emergence of language.[22] The ability to communicate effectively by the spoken word would make possible the accumulation and diffusion of knowledge on an unprecedented scale. The experience and knowledge of the elderly—at the time men and women only 40 years of age—would be a valued source of information. Since this human capital needed to be preserved and drawn upon, it explains why older and incapacitated people were cared for, and their value recognized by proper burial and enshrined in art. In aboriginal societies the medicine man or woman was often a person handicapped from birth or crippled by injury. Thus, "Kokopelli," widely revered in the rock art of the southwestern Four Corners area and Mexico is depicted as a hunchbacked arthritic figure who is associated with paintings of corn, deer, goats, atlatls, and bison, and often carries or plays a flute. With the advent of spoken language the value of information relative to physical strength would have changed dramatically and human society would have been highly motivated to preserve and transmit it to new generations. Based upon a reconstruction of the fossil evidence it is thought by many that the Neanderthals had a vocal tract more like an ape than the Cro-Magnon. If so, this might explain the extinction of Neanderthals, and their failure to develop the tool, art and hunting-gathering proficiency of competing Cro-Magnon peoples.

The affluence made possible by improvements in food acquisition methods would have provided the released time necessary to give attention to language development and to the rituals, ceremony and socializing that demand communication capacity. Big game hunting placed new demands on planning, organization, coordination and cooperation that depended on communication. It was the spoken word that allowed ideas and complex thought to be externalized. Memory, operated on by ritual, allowed knowledge to be preserved and, most important, accumulated. Writing, invented by 5000 years B.P. (and thereafter in many dispersed cultures), vastly accelerated the human capacity to preserve and accumulate thought.[23] But by this time humankind's vast knowledge of seeds, eggs and animals had already fomented the agricultural revolution made all the more necessary by the disappearance of so many of the great game animals.

The Agricultural Revolution; Reversion in America

In the Near East, beginning about 10,000 years ago, our ancestors abandoned the hunter-gatherer way of life that had served humankind so well over the vast stretch of at least 3 million years. The evidence appears in the form of several early

Neolithic farming villages dated from 9500 to 9000 years B.P. (Zohery and Hopf 1988). Plant cultivation in this area appears to coincide closely with the domestication of animals. Sheep and goats were domesticated first, but cattle and pigs followed closely thereafter.[24] Domesticated plants consisted of only 8 or 9 species of local grains such as wheat, barley and the legumes—lentils, peas and chickpeas. Sometime later bitter vetch and flax are added to the crops. About 3000 years after grain agriculture, various fruits—olive, grape and fig—are cultivated. All these plants were domesticated forms of the wild varieties that were indigenous to the area.[25] Subsequently plant cultivation appears in Egypt, the Balkans, and the West Mediterranean 7000 years B.P., Central Europe and the Ukraine 6500 years B.P., and Scandinavia about 5000 years B.P. Evidence for agriculture in New Guinea, where there were virtually no animals suitable for hunting, is dated 9000 years ago (Reader 1988).

In North America although the earliest evidence of agriculture is in Mexico, 10–9,000 years B.P., products were added slowly, one by one, over thousands of years as if cultivation were a hobby used to supplement hunting and gathering. When the first Europeans arrived in the sixteenth century there was great variability among the North American tribes in their dependence on agriculture versus hunting and gathering. In California acorns and hunting were important means of subsistence. In the Pacific Northwest salmon fishing supplemented by gathering was paramount. On the Great Plains many tribes, such as the Pawnee, Cheyenne and Arapaho, had well-developed horticulture and pottery arts. The peaceful Pueblos of the Southwest grew cotton, corn, beans, tobacco and squash.

The influence of opportunity cost on tribal choice of culture is well illustrated by the effect of the reintroduction of the horse to North America by the Spanish. The Spanish mustang—a docile and easily domesticated member of the *Equus* family—was a revolutionary innovation to the Plains indian causing many tribes to revert to the bison hunt as a permanent way of life. Wedel (1936) reports that the introduction of the horse caused the Pawnee to change from a sedentary tribe devoted to agriculture to one in which the chase and maize culture were equally important sources of sustenance. More dramatically the Cheyenne and Arapaho abandoned their villages, agriculture and pottery arts to become bison hunters (Wedel 1940; Strong 1940). Consequently the fierce "fighting Cheyennes" known to the plains settlers were almost entirely a recent creature of the horse. Tribes such as the Apache, who were already subsisting on bison when the Spanish arrived, simply adapted the horse to their hunting culture.

Although Cornado and other conquistadors lost or abandoned horses in the sixteenth century, it was not until the permanent colonization of New Mexico in the first half of the seventeenth century that peaceful Indians, forced to tend their horses, learned horsemanship from the Spanish. During this period, horses and knowledge of them were acquired by the Apaches and other tribes, and by the 1650s the colonial settlements faced the formidable Apaches, on horseback, whose raids became legend. All the power of Spain in America failed to subdue them. Then out of the Rocky

Mountain headwaters of the Arkansas River appeared a little known tribe of hunter-gatherers who abandoned their homelands and took to the Plains on horseback. They became great bison hunters and by 1725 invaded the Apache lands of Colorado, Kansas, Oklahoma and West Texas. Entire tribes of Apache who had been the scourge of the Spanish disappeared. The invading Comanches exterminated the Eastern tribes and drove the Western tribes into Arizona and New Mexico. The Comanches were the greatest warriors ever to ride the high plains and plateaus of Texas. They were without peer on horseback, with men, women and children skilled in the saddle. Their raiding parties ranged up to 1000 miles, and across the Rio Grande deep into Northern Mexico; their loot sometimes consisted of hundreds of horses in a single moonlight raid. They were known for their " . . . boast that the warrior tribes permitted Spanish settlements to exist on the fringes of Comanche territory only to raise horses for them" (Fehrenbach 1983, 36). The Spanish were never again to muster any semblance of control of West Texas; nor were the white Americans able finally to control bison country until 1875 when the remnants of the fierce Comanche tribes finally surrendered at Fort Sill, and the bison were all but exterminated and replaced by the long horn steer. For a century and a half the history of the American West was a history of fear and terror of the Comanches who, prior to the arrival of the mustang, had picked berries and dug roots while hunting miscellaneous game in the Eastern Rockies, and were a threat to no one.

Genesis: A Folk Memory of Conflict Between Two Cultures?

The remnants of our prehistoric past that reside in our cultural traditions today is well illustrated by a fascinating interpretation of Genesis as a myth of conflict between the agricultural and hunter-gatherer way of life, written from the perspective of the latter (Hamblin 1987). According to this reconstruction the Garden of Eden represents the economic affluence achieved by humans as hunter-gatherers who lived abundantly on the plants, animals and fishes placed on Earth by God for the benefit of humankind. Then Eve broke the cultural command not to eat the fruit of the tree of knowledge. But what "knowledge" was contained in this fruit? It was knowledge of the reproductive cycles of seeds, eggs and animals, which was the human capital foundation of agriculture.[26] Some were already practicing agriculture and departing from their ancestral imperative, causing a bifurcation of the cultural message. The warning against this dangerous new direction is expressed in the punishment of Adam and Eve: " . . . cursed is the ground for thy sake; in sorrow shalt thou eat of it. . . . Thorns and thistles shall it bring forth to thee; and thou shalt eat the herb of the field" (Genesis 3: 17–18).

Eve bore two sons who were split on the ancestral imperative: Cain became a tiller, while Abel was a herder of sheep.[27] Cain made offerings of the fruit of the ground to the Lord, while Abel offered the first of his flock. Abel's offering was respected by God, but Cain's was not. So Cain killed Abel, implying that the culture was in danger of losing the skills of the hunter-gatherer in which case there could be

no turning back from the world of thistles and thorns. Then came the flood, all the game animals are in danger of extinction, and so on.[28]

This allegorical interpretation is plausible in many ways. First, the timing is right; second the location is right; and third, the events described correlate with what is known about this period and place. The first evidence of agriculture appears about 9500 years B.P. in the fertile crescent of the Tigris and Euphrates rivers. Surely this was not an unclimatic event after more than 5 million years of bipedalism, 2.5 million years of tool use, and a very successful adaptation to hunting and gathering. Moreover, the Sumerians invented and were using the first written cuneiform language 6–5000 years B.P., a language which produced many epic poems that obviously influenced the Hebrew story of Genesis. The Sumerians had a cuneiform word for "Adam" which meant "settlement on the plain." They also had a word for "Eden" which meant a "fertile plain." Interestingly there was no word for "Eve," but their word "ti" had two meanings: "rib" and "to make live." The Hebrew scholars, not appreciating this dual meaning, concocted their story that God gave life to Adam's rib creating the first woman. The Sumerian tablets, besides telling us of "Adam," "Eden," and the "lady of the rib," also tells us of a Great Flood and of their King Gilgamesh who went down to the Gulf in search of the Tree of eternal life.[29]

Moreover, it is known that there was a sudden warming trend 7–6000 years B.P. shrinking the ice caps and raising the sea level. The Persian Gulf would have filled with water during this period reaching its current level about 6000 years B.P. These considerations have suggested to Juris Zarins (Hamblin 1987) the hypothesis that the Garden of Eden was located at the upper end of the Persian Gulf, for it is written: "and a river went out of Eden to water the garden; and from thence it was parted, and became of four heads . . . the . . . Pison . . . Gihon, Tigris . . . and . . . Euphrates" (Genesis 2: 10–14). Of course the Tigris and Euphrates still flow, while the Pison and Gihon probably refer respectively to the Wadi Batin, a fossil river in Iraq, and the intermittently flowing Karun River in Iran.

Finis

The significance of prehistory to humankind, circa 2000, is that all we are today—our great cultural attainments, and ever growing potential, our biological and human capital achievements—are a product of that prehistory. If there is much that is new in historical time it is because we have continued what began in prehistory, but have had so many millennia to accumulate the human capital made possible once our hunter-gatherer ancestors learned to learn. If we are a "kinder and gentler" species today than were our ancestors who slaughtered the great mammoth and bison on two continents; if we can care enough to launch a massive effort to save three great whales trapped in a hole in the Arctic ice; if we can debate reintroducing the timber wolf into Yellowstone Park; it is because we can now afford to do all these things and have learned to treasure the value of individual responsibility for

preserving and managing natural resources.

But change has been episodic, not linear, as we have leaped from one long confining plateau to another less than a half-dozen times since we escaped—so improbably—our primate origins which took three billion years of sporadic change to create. Through all these sweeping changes is discernable the blurred outline of continuity in humankind's development of the capacity to respond to effort prices, to create cheaper techniques and products to substitute for dearer ones, to develop property rights, and to accumulate and preserve knowledge, our most precious capital asset.

Notes

1. It is, and must be, a speculative extension of what we know from the paleoanthropological and biological records. This is because what we know about prehistorical humankind is interpreted from the artifacts and remains that our remote ancestors left behind and that have survived biodegradation, from backward extrapolation of what we know from the study of extant prehistorical societies during the last 96 years (Boas 1897), and from genetic differences between humans and other primates today. One of our most important characteristics as humans is to pattern-search our data, and try to make dumb facts speak with understanding. I make the case that economic principles help us to achieve this understanding. The theme is one of `natural,' as distinct from `political,' economy (Hirshleifer 1978), but, as will be seen below, I think the outlines of `political' economy emerged in antiquity.
2. Nonhuman primates, such as baboons and chimpanzees, are known to prey on small vertebrates. There is also evidence of elementary forms of planning and cooperation among chimpanzees in their predatory activities; they also transport materials to use as tools. " . . . some level of predation as well as tool use is not unique to the Hominidae. Much, if not all, of the evolution of these activities in the hominid lineage was therefore primarily a shift in emphasis rather than the introduction of completely novel behavioral patterns (Trinkaus 1986, 110–111)."
3. Glaciation of the earth actually begins before the Pleistocene about 14 million years B.P. in the middle Miocene. See Klein (1989, 29–35) for a summary of late Cenozoic ice age climate and its significance for humankind.
4. "Such a structure (the external nose) would have enabled members of *H. erectus* to retrieve moisture from exhaled air . . . (which could be) used for humidifying the next breath without using additional body moisture . . . Such a system would have been more efficient at conserving body fluids . . . (which) would have been important for a diurnal primate exploiting resources in open country, especially in relatively arid regions" (Trinkaus 1986, 120). In fact it is possible that these people were capable of running prey to exhaustion (Trinkaus 1986, 128). (American aboriginals had the capacity literally to run down a horse or deer by pacing the animal.)
5. See Klein (1989, 171, 218) for references.
6. For a controversial study placing our common mitochondrial DNA ancestor at 200,000 B.P., and two rebuttle notes, see Vigilant et al. (1991); Templeton (1992); and Hedges et al. (1992).
7. In North America, horse bones are among the most common Pleistocene fossils (Martin and

Guilday 1967, 41–42).
8. Dwarfing may have provided a higher biomass growth rate enabling the bison to overcome a high rate of Paleolithic harvesting of megafauna. "Human technology, including use of missile weapons, greatly reduced the counterattacking defensive advantages of larger size and emphasizes concealment and speed of flight. At this point of increased pressure of human predation, the genetically selected optimum body size of many forms declines sharply" (Edwards 1967, 149). Hammond (1961, 321) has noted that a considerable reduction in size has occurred since the beginning of the century in the major beef breeds of cattle. This is due to deliberate selection for early maturation in body proportions. Under appropriation, investment favors the smaller animals with a higher biomass growth rate. But under common property conditions, Paleolithic hunters (also the Hazada and Ache: Hawkes, O'Connell, and Jones 1991) selectively harvested the larger, slower growing animals.
9. Caughley (1988) offers a population diffusion and growth model to account for the geographical and temporal distribution of radiocarbon dates at prehistoric sites (many of them moa bird kill sites) in New Zealand. According to this model colonization began on the northeast coast of the South Island 1050–900 B.P. and diffused at an accelerating rate throughout New Zealand. Accordingly, the population increased about 3 percent per year (doubling every 20 years), and sea elephants, sea lions and about 25 species of birds became extinct. Earlier, similar models were used (see Caughley 1988) to structure hypotheses concerning the colonization of Australia more than 30,000 B.P. and the colonization of North and South America about 11,000 B.P.
10. Yet it has been estimated that a population of only 15,000 people in northern Eurasia would need to consume up to 60,000 horses or 10,000 bison per year (Vereshchagin and Baryshnikov 1984, 508).
11. Some African hunter-gatherer tribes, such as the pygmies, have fared well because they depended on trade with their agricultural neighbors (Reader 1988, 155). But for the Kung, it is the opposite; their neighbors have survived draughts and poor crops by joining the Kung in gathering mongongo nuts and other wild plants. During the third year of a draught phase the Kung consumed an average of 8.3 percent more calories and 55 percent more protein than the estimated daily recommended allowance for people of their stature and activity (Lee 1968; Lee and Devore 1976). But see Hawkes and O'Connell (1981) for a critique of Lee's interpretation of the Kung data: Lee's foraging calculations do not include the time spent in processing food. The mongongo nut requires considerable cracking/roasting time, which correspondingly reduces the net caloric yield per hour of labor.
12. This is of course precisely the normative argument for using Nash mixed strategies in certain games of conflict.
13. As stated by a Karok woman "They . . . burn the brush . . . so that good things will grow up. . . . Some kinds of trees are better when . . . burned off. . . . But some . . . disappear . . . the Manzanita . . . does not come up when it is burned off. . . . They are careful lest the(se) trees burn" (Lewis 1973, 50–51).
14. As explained by a Cree Indian: "See, you start a fire at the top of a meadow in the afternoon, when you feel the wind change, the way the cool air does at that time. This way the fire burns toward the low part of the meadow. . . . Its safe. You have to know the wind" (Lewis 1980, 82).

15. Modern experiments have tested the Amerindian policy of burning to improve game productivity. Thus deer in recently burned over chaparral cover show marked increases in numbers, size and improvement in health (Biswell 1967, 81).
16. Among the Ache hunter-gatherers of Eastern Paraguay the most successful hunters devote more, not less, time to hunting than less successful hunters. They also share disproportionately their surplus with people outside their family group. In return they gain increased access to extramarital mates producing illegitimate children, and a higher survivorship of their offspring (Kaplan and Hill 1985; Hawkes 1990).
17. Of course we have no idea as to whether the early property rights systems were based on regimes of private property. By property rights, I mean rules governing the actions of individuals. Aboriginals had concepts of both private and tribal property, and both probably originated in this early period with the great increase in individual (or group) possessions.
18. This is illustrated in John Hughes's (1982) account of the seasonal closing of the Alaska cannery where he worked in the summer of 1951. A half-Eskimo winter watchman was removing the locks and chains from various items of property. When asked why, he stated that locks were not needed now that the Christians were gone. For a discussion of the role of "repeat business" in inducing cooperation in the absence of enforcement see Hirshleifer (1978). Also see Hawkes (1991) for a discussion of reciprocal altruism or "delayed reciprocity" wherein those in close relationship share resources in return for future shares, and for a generally incisive analysis of "sharing" in the context of individual incentives and game theoretic interactions.
19. For an economic analysis of the Kula Ring, see Landa (1983).
20. See Heizer (1955, 4–7) for these and many more examples.
21. Lewis quotes the reminisces of a Beaver Indian woman: "Why the bush is so thick is because they (Indians) stop burning . . . From about five miles from here you could see straight prairie right to Childs Lake and that timber. Did you ever see them prairies? . . . It was really prairie, just prairie, you know; here and there you see little specks of woods, and if there were trees there, they were quite high" (Lewis 1980, 76). The imposition of fire prevention policies for many prior decades led to the great Yellowstone Park holocaust of 1988. Similar policies imposed on the Australian Aborigines " . . . resulted in the sporadic eruption of gigantic wild fires feeding on several years' accumulation of litter, causing leaf scorch heights of up to 20m, with the death of mature woodlands of . . . (Cypress pine) which the policy was intended to protect . . . " (Jones 1980, 125).
22. Linguists are split on the antiquity of language: radicals suggest that the roots of spoken language could go back 100,000 years, while traditionalists accept an origin of at most 15,000 years B.P. (Ross 1991). Of course the date for the common ancestor of modern humankind may be closer to 50,000 B.P. Klein (1992) notes that this is suggested by the archeological evidence for a radical biologically based change in human behavior 50–40,000 B.P. Under Klein's hypothesis the development of language would have been a later consequence of the biological change. I assume that the dates based on DNA studies are roughly correct, and that we have to account for a much later occurrence of the cultural revolution. There are still other perspectives, e.g. Sofeer (1990) argues that the biological and archaeological records are consistent with a socio-cultural innovation that introduced bi-parental provisioning of the young, division of labor and food sharing. But I would argue that these and all manner of other cultural innovations could

have been made possible by the development of language.
23. An interesting hypothesis, supported by the archaeological evidence, argues that the precursor of Sumerian writing was a clay token accounting system, appearing 11,000 B.P., used to preserve records and to facilitate the exchange of property (Schmandt-Besserat 1978). Thus the first forms of written language may have been invented as an aid to memory and security in contracting for property (Sumerian exchange included land, animals, vessels, bread, beer, clothing, furniture, etc.). Early symbols then evolved into Sumerian pictographic writing and ultimately ideographic and phonetic writing.
24. It would appear that sheep domestication predates agriculture in this region: " . . . most authorities now agree that the first species to be domesticated in the Near East was the sheep, 10,500 years ago or so" (Fagan 1989, 265).
25. In virtually all aboriginal societies studied in the last century, hunting was a preoccupation of men and gathering was the province of women. It therefore would appear likely that the agricultural revolution was due to women's knowledge of seeds, herbs and edible plants.
26. As noted in endnote 24, it was the woman, in this case Eve, who transmitted the agricultural human capital.
27. Not quite a hunter-gatherer so the allegory here is weak, but Abel was a nomad nonetheless. Sheep herding does appear to be an intermediate step in the turn from hunting.
28. As Ed Ames has pointed out to me a sharper contrast between hunting and tilling is found in Genesis, 25–27, where Esau was a hunter, whose birthright was bought by Jacob, the farmer-herder.
29. Incidentally, he found it, but it was stolen from him by a serpent!

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