Mastery over nature began with the development of the hand, with labour, and widened man’s horizon at every new advance. He was continually discovering new, hitherto unknown, properties in natural objects. On the other hand, the development of labour necessarily helped to bring the members of society closer together by increasing cases of mutual support and joint activity, and by making clear the advantage of this joint activity to each individual.

—FRIEDRICH ENGELS

“The part played by labour in the transition from ape to man” (1896)

INTRODUCTION

From the materialist viewpoint essential to the paleoanthropologist, cultural systems are socially—rather than biologically—transmitted behavioral complexes by which some organisms mediate their relationship to their surroundings, including other organisms (Kummer 1971).

As the cultural means of adaptation becomes fully efficient, it serves to mediate between organisms and environment in several ways. First, it alters some set
of natural resources, selected deliberately or unconsciously by members of society from among the larger range of environmental offerings. Second, it keeps some set of natural environmental factors which could be deleterious to their survival from impinging directly on a sufficiently large number of the organisms to permit the social group to survive. Third, it provides for the socialization of new members, and provides them with some shared set of cognitive orientations. Fourth, it orders the culture-bearing organisms both with respect to each other and with respect to their access to the set of relevant natural resources. In the process, it secures the satisfaction of at least a minimum essential set of biological and psychological requirements for the necessary number of organisms sharing this means of adaptation. By satisfying those needs more efficiently within the social context than would be possible outside it, the cultural system ensures the replacement of individuals who leave the socio-cultural group permanently by new recruits (Aberle et al. 1950; Kummer 1971). Cultural adaptations effect changes in the natural environment, and it is the culturally altered environment to which the species must then adapt, biologically as well as culturally. The most successful, fully efficient cultural systems available to modern men create largely artificial environments characterized by such features as many-family urban residences; rapid long-distance transport; controlled indoor climates (and accidentally altered outdoor climates); deliberate large-scale and long-term information storage, retrieval, and manipulation systems; and modern drugs, medicines, and health care. The implications of such thoroughly altered ecosystems for the biological evolution of our species are extremely important. Even though cultural alteration of environment must have been thousands of times less drastic during the earlier history of hominid existence, it has not been a completely negligible factor for at least the last two and a half million years.

Clearly, judgments about the effectiveness of the cultural adaptive systems of our ancient ancestors and relatives must be largely based on the durable material traces of their activities. (Some evidence of undeniable value is also provided by the skeletons of the animals themselves, but this chapter is only peripherally concerned with hominid body morphology.) Material residues of prehistoric human activities include both recovered artifacts—objects made or altered by man and their contexts—the containing sediments; associated biological, mineral, chemical, and radiological materials; and the positional and numerical relationships between these categories. Most earlier excavators deliberately or unconsciously focused their attention on lithic implements above all else. That is understandable. After all, lithics are ordinarily the longest-enduring intentional material products of human craftsmanship. However, we now realize that artifacts alone are potentially far less enlightening about past lifeways than is the total configuration of artifacts, contexts, and relations.

An evaluation of human capacity, based on preserved material residues of human behavior, can be successful only insofar as the variety of that behavior is directly reflected in aspects of the recovered materials. Occupation residues are regarded as analogous to communication channels: they are the media by which information is transmitted from the prehistoric past to the modern world. The information they
contain has been stored in material form—just as though the residues were written documents—and an appreciable part of the information can be decoded and understood by prehistorians and paleoanthropologists. But lithic implements contain only a very small part of the message from the past. As communication channels, their capacity is limited; the total variety of information they preserve is restricted to an extreme.

The size and nature of available raw material, the limited technological means available to shape it, the size of the human body itself, the strength of the average stone knapper and tool users and the kinds of tasks in which tools were to be used, all imposed severe constraints on their variability. The shape and size of a useful stone tool were not subject to unlimited arbitrary variation. By themselves, lithic implements can give us only the feeblest reflection of the complexities of mental processes of prehistoric men.

In contrast, the variety of information effectively transmitted in any modern spoken or written language is immense. That is because languages employ a sizeable number of arbitrary symbolic units of information (e.g. phonemes, letters), which may be recombined in several different ways, so that the number of different symbols which might potentially occur at any place in a message is great (Carroll 1955). Information theorists commonly measure the amount of information transmitted in “bits” (binary digits), each of which can be thought of as a single dichotomous specification (a division of alternative meanings into applicable and nonapplicable sets). Each bit added doubles the total number of distinct meaningful items that may be produced. Written English has been estimated to use about twenty-six bits of information (that would be sufficient to produce all the written words in current use), but no single individual uses anywhere near this theoretical capacity. College graduates may have vocabularies surpassing 100,000 English words (most of which would not be used in ordinary conversation). If each of the 100,000 words were equally probable, 17 bits would provide more than adequate information-carrying capacity for their unequivocal transmission. Daily speech might require only 13 or 14 bits. Since all transmissions are affected to some extent by “noise”—interference which obscures or alters the content of parts of the information sent—all communication systems incorporate a certain amount of redundancy to ensure that the meaning will get through.

It is impossible to specify with precision the number of bits of information which might be carried in lithic implements considered as communication channels; for one thing, that number changed from time to time and place to place. Nonetheless, the variety of information which can conveniently be stored in flaked stone implements within the constraints I have mentioned has always been low—probably never more than eight or nine bits at any time. All other things being equal, the amount of information which can potentially be transmitted by a lithic implement must vary directly with the overall size of the artifact, the extent to which it is altered by retouch, and the number of distinct working edges it displays. Obviously, more plastic or malleable materials are often relatively more easily subjected than chipped stone to decorative treatment which does not affect whatever technological functions they
may possess. Such materials and their decorations have a considerably higher potential capacity as communication channels than stone tools. Joining several individual pieces to form a single compound tool further increases the potential variety of information the tool can transmit. Nevertheless, even at their most variable, single implements considered in isolation can carry no more than a small fraction of the potential information which can be gleaned from the same implements analyzed in the total contexts in which they were recovered. That is because so much additional information is stored in the nature of surrounding sediments and associated materials, relationships between the frequencies of recovered items, and the positions in which they are found. To maximize information recovery, we should look on the occupation horizon as a whole rather than the individual implement or the artifact type as the communication channel. Unfortunately, that obviously cannot be done with collections from early excavations, and we are often forced to rely exclusively on the lithics.

Even under ideal conditions, information from the prehistoric past does not get through to us entire and unchanged. As a communication channel, the prehistoric record is exceptionally “noisy.” The information we can recover has been extensively altered by several kinds of interference and it is only after the most careful and intensive efforts by the analyst that the message may be decoded. Something is known about the nature of the noise in the fossil record, and we are gradually learning how we may allow for part of it, at least, in the decoding process.

We may express the relationship of the information in the fossil record to the relationship in the living system which produced it as follows:

\[
\text{Information in fossil record} = \text{Information in living system} + \text{Generator noise} + \text{Noise during transmission} + \text{Receiver noise}
\]

Each of the three kinds of noise adds some irrelevant information to the message produced by the living system (Beerbower 1968).

Let us suppose that the living system is the total set of activities involved in butchering an animal. The tools and bones left on the ground, and the contexts in which they are found, are the information received. During “message generation,” noise is added by random error, and by both deliberate and unconscious alteration of the abandoned items. A tool unrelated to the butchering process may be accidentally lost in the butchering area. Because he intends to use them in another operation, prehistoric man removes some of the butchering tools to another location. As men move around, artifacts are unconsciously kicked out of the places where they were originally deposited.

As the occupation area is abandoned, transmission noise begins to affect the message in the ground. The ravages of time take their toll, as perishable materials gradually disappear and imperishables are broken down to smaller sizes by the passage of men and animals and the weight of overlying sediments. Gravity, frost, and slopewash move the materials downslope and realign them, sorting them by size at
the same time. If the earth dries and cracks, or ice wedges form, foreign material may drop into the cracks and be incorporated into the site sediments. Large parts of the site may be completely eroded away, and thus lost forever. Animal disturbance also affects site sediments: animals may burrow into the deposits, removing site materials and adding material from other horizons. The role of earthworms in reworking sediments has been discussed by so eminent an authority as Charles Darwin (1896). In the process, worms may completely remove intervening sediments from between two layers of occupation debris, making them appear to be a single level. If a site continues to be occupied by man, material gets well scuffed about, and later items are trodden into earlier levels.

Last, a considerable amount of noise is added during reception of the message by the living prehistorian. Some of the interference comes from legitimate error: what the excavator believes to be a representative sample of information about the lifeways of a prehistoric group may in fact reflect just one or a few specialized activities. The solution of a particular problem crucial to an understanding of the prehistoric past may require that special effort be devoted to collecting data relevant to that problem, to the relative neglect of some other kinds of information. It is also true that none of us really knows what all the potential sources of information in a prehistoric occupation may be, or how to go about collecting that information, and so we all fail to gather much material which may prove to be of critical importance in the future. A good deal of the interference, however, comes from real blunders on the part of the prehistorian. There are a great many so-called prehistorians who should never be allowed near a site. Even the best scholars occasionally become careless in collecting or analyzing data, and thus contribute misinformation to the decoding process. And, try as we may, we all inevitably misinterpret a part of the information we do collect, simply due to the fact that science progresses, and the interpretations which seem most likely now, will certainly be altered somewhat by future insights. By the time the transmitted information has been altered by these factors, the original nature of the butchering-camp may be very hard to recognize.

The fact that so many potential sources of error can be enumerated should not be discouraging—that we can recognize them indicates that we shall eventually be able to deal with them. As time goes on, we are continually learning how to evaluate, predict, and control these causes of interpretive error. For the time being, we must recognize that the most trustworthy evidence about prehistoric lifeways can be gathered by the excavation of largely undisturbed, single relatively short-term deposits of occupation debris. The amount of such material available is still infinitesimal when we consider the vast areas of the earth and the immense periods of time which have been witness to hominid evolution. When Washburn published his 1959 (Washburn 1965) paper on this theme he qualified his conclusions as speculative because of inadequate data. Even though pertinent evidence has been accumulating at a heartening rate during the last 15 years, the observations in this chapter cannot be more definite or conclusive than those Washburn made. There is still so little material, and what we have is so unlikely to represent the whole fairly, that
every small addition of empirical data can be expected to change these speculations radically.

THE “CULTURAL CAPACITY” OF NON-HUMAN PRIMATES

The general anthropological literature in English abounds with mistaken caricatures of the uniqueness of the human condition. Among those crucial potentiating capabilities claimed as unique to the hominid family, whose absence would preclude the development of fully effective cultural adaptations, are toolmaking, symbolic behavior, and consciousness of self-identity. However, modern laboratory and field studies of non-human primates show that these faculties are not exclusively restricted to hominids. Van Lawick-Goodall’s observations of the toolmaking behavior of wild chimpanzees demonstrated that those pongids not only manipulate suitable found objects as tools but also regularly modify naturally occurring raw materials to increase their suitability for the tasks at hand. Her descriptions of the production and use of “termite-sticks” are too well-known to require further comment (Goodall 1965). Premack (1971) has reported what seems to me convincing evidence of a well-developed “symbolic capacity” in one great ape. He succeeded in teaching a chimpanzee arbitrary values for a set of plastic shapes which the chimp then used, often in completely original combinations, in apparently “intelligent” communication with the experimenter. Only some symbols were used as object-names; others were given quite abstract linguistic content. By manipulating symbols already learned by the experimental animal, Premack was able to teach her entirely new linguistic concepts. There is bound to be some reticence to accept his results, but I have not seen any compelling disproof of them. The criticism that the animal did not, herself, invent the values with which the plastic forms were endowed is no contradiction of his conclusions, since most human symbolic behavior is learned in the same way, not invented by each individual. Gallup (1970) showed that chimps soon learned to distinguish their own mirror reflections from other individuals.

Isolated anesthetized animals, marked with indelible color in parts of their anatomy not directly visible to them, showed recognition that marking had occurred after observing their reflected images.

These experiments and others show how much of what we have naively considered to be part of an exclusively human behavioral domain is shared with other animals, especially our closer primate relatives. The gulf between the behavior of *Homo sapiens* and that of the pongids is obviously immense, but it is equally clearly a quantitative rather than a qualitative one.

It is true that what I have called a fully effective cultural adaptation is restricted at present to members of the species *Homo sapiens*. However, the fact that modern man has developed such an effective adaptation does not imply that the cultural systems of his earlier ancestors were as efficient adaptive mechanisms. In fact, an examination of the material residues of their behavior quite certainly shows that not to have been the case.
EARLY LITHIC ARTIFACT ASSEMBLAGES

The earliest convincing evidence of implement manufacture on a more elaborate scale than that practiced by chimpanzees is the occurrence of stone artifacts in deposits from the Omo Valley in Ethiopia and the area just east of Lake Rudolf in Kenya. The occurrences in question are stratigraphically latest Pliocene or basal Pleistocene in age and have been dated at between two and three million years (lower part of the Shungura Formation, Omo), and around 2.61 ± 0.26 million years (Koobi Fora tuff A at KBS). One occupation site about 2 million years old is known from primary depositional context in the Omo. Site FjJj2 is a scatter of lithic artifacts on what was a temporary land surface in a back swamp or marginal flood basin. An exposure of 10 square meters has yielded 95 small vein-quartz lumps, pebbles, and flakes, some of which are utilized, but none are intensively retouched (Merrick et al. 1973). The amount of information stored in these pieces is minimal (not more than about two bits). At Koobi Fora, artifacts (in fresh condition) and bone occurred in the base of an aeolian tuff, or at the interface between this and lower fluvial deposits. Some vertical scatter was noted, and it is not yet clear whether the accumulations represent one or several phases of hominid occupation. There are a number of spatially discrete artifact-rich occurrences in comparable stratigraphic situations at Koobi Fora: only two (FxJj1, FxJj3) are known in some detail. At the time of occupation, the sites were apparently located along ephemeral water courses in a generally swampy flood plain. The excavated artifact series from FxJj1, exposed over some 45 square meters, totaled 122 pieces (excluding manuports) after the 1971 field season. Of these, 7 pieces were chopper/cores and 115 were flakes; most pieces are made of lava, but there are a few quartz and chert artifacts. Associated bone includes *Hippopotamus* and pig tusk, antelope teeth, and other ungulate remains. Some of the antelopes were very old at time of death. At FxJj3, excavation of some 20 square meters of intact strata produced 112 artifacts: one is quartz (a flake), the rest are lava. There are four chopper/cores in the series, 107 whole or broken flakes, and a hammerstone. Preliminary analysis of the fauna identified some fragments of *Hippopotamus*. The patchy artifact scatter at FxJj1 seems to be restricted to an area about 8 meters in diameter. At FxJj3, areal limits are not known. It is possible that both occurrences represent single, ephemeral, but relatively intense occupations rather than repetitive visits or long-term occupations of lower intensity. The excavator assigns the recovered lithics to the Oldowan industrial complex (Isaac et al. 1971; M. Leakey 1970). A third somewhat earlier occurrence has not yet been described.

At Olduvai Gorge, a series of very early occupation floors has been excavated and results of that work have been extensively published by M. D. Leakey (1971, 1975). The tuff-sandstone sequence Hay designates the Upper Member of Bed I produced assemblages assigned to the unevolved Oldowan complex. It is estimated that this member may have taken 50,000 to 100,000 years to accumulate. The sequence has been dated to around 1.70–1.75 million years (K-Ar) (Hay 1971). In addition to several vertically diffuse scatters of artifacts and fauna, there are five real “occupation floors” atop old land surfaces, with minimal vertical spread. The diffuse scatters
are generally embedded in claystones representing old mudflats into which materials sank or were trampled during the course of hominid visits (of unknown frequency or duration). The mudflats were apparently not exposed long enough for complete stabilization and adequate intensive weathering to produce paleosols like those underlyng the true occupation floors. The latter occur on land surfaces, along the marshy eastern margin of a former saline lake, the southeast shallows of which were periodically freshened by streams flowing from nearby volcanic highlands. One typical Oldowan assemblage was found in a comparable situation in lower middle Bed II at the MNK locality. The horizon has not been dated but is certainly younger than the only securely dated level in Bed II (Tuff II\(^{A}\), whose age is thought to be about 1.7 million years. The range in dates for the Upper Member of Bed I and Tuff II\(^{A}\) in Bed II correlates well with the calculated age of Middle Villafranchian faunal-bearing deposits in the Auvergne. Such a correlation is certainly not discordant with the composition of faunas from the Olduvai horizons in question (Hay 1971; M. Leakey 1971, 1975).

Leaving aside the vertically diffuse occurrences, occupation sites with unevolved Oldowan assemblages are so rare, and their contents and spatial patterning are so variable, that few regularities in site typology can be defined. Spatial segregation of activities is indicated by the presence in DKIA of a 4.25 × 3.65 meter circle of loosely piled stones, enclosing an area within which occupation debris was relatively rare compared to the situation outside the ring. At FLK Main, on the "Zinjanthropus" floor, small bone fragments, light-duty tools, and small debitage were largely concentrated in a 6.4 × 4.6 meter area, bounded on the south and east by a relatively artifact-free zone some 2.4–2.7 meters wide. Beyond the clear zone, there is a dense scatter of heavy-duty artifacts and manuports, as well as most of the larger bone fragments. The significance of these undoubtedly patterned distributions is still elusive, however. The faunal content of the Olduvai occupation floors is quite variable. In some levels (DKI level 3, "Zinj" Floor) the bone remains which are likely to be residues of hominid meals are largely from bovids, suids, and such larger mammals. At FLKNN (level 3), a number of individual broken-up tortoiseshells were found on an occupation floor, with bits of several kinds of small animals and some large mammal remains. FLKNI (level 6) is probably a butchering site; it yielded much of the skeleton of a young but very large elephant. The bones of this creature have been moved about, but the distribution suggests that the animal may have been mired or died and been butchered on the spot. Possible hominid coprolites from one level in Bed I contained bits of lizards, rodents, insectivores, and birds (M. Leakey 1971). It looks as though the site occupants had very catholic tastes; they may have relied on smaller mammals, reptiles, birds, and amphibians for much of their diet, utilizing whatever windfalls they were fortunate enough to obtain in the way of carrion or scavenged fresh carnivore kills, and perhaps occasionally killing a large mammal themselves. There is no evidence for deliberate selection among the available sources of animal food on the part of the authors of unevolved Oldowan assemblages.

All the occupation floors but one (FLKNNI, with only 17 artifacts) produced far more _debitage_ than shaped or utilized tools: unretouched flakes and core and flake
fragments make up from 70 to 90 percent or more of the total assemblage. All the sites produced spheroids, subspheroids, and/or unaltered manuports; sometimes these were abundant in comparison with the remaining artifact categories. In my opinion, such pieces are the only possible candidates for identification as weapons in any Oldowan lithic assemblage. Conceivably the abundance of manuports and spheroids on some occupation floors is a result of intentional stockpiling of missiles near favored hunting localities, or for defense at “living sites.” On the other hand, stockpiling involves rather complex behavior patterns, and it is equally possible that hominid occupations were simply sited at or very near localized sources of raw material. Stone used for artifact manufacture—lavas, quartz, quartzite, and chert, primarily—was available locally in outcrops or as stream-transported cobbles.

Generally speaking, deliberately retouched flake tools are rare and neither the overall form of the artifact nor the shape of the retouched edge seems to have been standardized. Although Mary Leakey has, for convenience in description, recognized several subgroups in the large tool series, most of these seem to me to be more the product of the classifier’s sense of order than the result of attempts at standardization on the part of the implement-makers. The spheroid–subspheroid–core–discoid–chopper–heavy-duty scraper categories in particular seem to be segments of a spectrum of more or less continuous variability. If the suggestion that Oldowan implement makers had not imposed extensive standardization on their lithic products proves true, I am equally convinced that the lack of standardization does not reflect any structural incapacity of the toolmaker’s hands for precise manipulation. Among the pieces from the lowest occupation horizon in Bed I there are some small artifacts with regular, diminutive flake removals which I am sure could only have been produced by a hand capable of a well-developed “precision grip.”

Artifacts from different Oldowan occupations are sometimes distinct in appearance. Size differences, as well as differences in proportional representation of major artifact groups or raw materials, are documented. The inter-assemblage variations noted can plausibly be ascribed partly to chance, partly to the ready availability of different stone sources in the close vicinity of the different occupations, and partly to the uses to which the tools were put. I find no convincing evidence for intentional stylistic variation between the artifact assemblages from different localities in either the published descriptions and figures or the available cast series. There seems to be no evidence that the toolmakers at any locality were on the average producing a superior product to that made by hominids from any other locality. In itself, that is suggestive. The fact that any variation in the ways different groups made Oldowan lithic assemblages is obscured by the general lack of standardization of the artifact series may show that selection pressures to improve the learned repertoire of artifact-making skills were not especially intense. This should mean that the artifact-making behavioral repertoire was not as crucial to group survival as is usually suggested.

Sites in the Omo, at East Rudolf, and at Olduvai provide evidence that at least two distinct hominid lineages coexisted in East Africa during the period when Oldowan assemblages were made. Which one or more species may be the authors of the artifact assemblages is unknown, and cannot be determined on the basis of
the evidence now available. The data at hand certainly do not preclude the possibility that all of them may have made stone tools. Some time ago Mayr proposed that, once culture as a means of adaptation appeared, there would be only one major niche open to a man-like creature, so that no more than one hominid species could exist at any given time (Mayr 1950). While this may be true (for a given region) once culture assumes a major role in adaptation, the Oldowan assemblages really do not in themselves provide convincing evidence that this was yet the case. It is more reasonable at present to suggest that, although the Oldowan complex provides the first recognizable, unequivocal evidence for the beginnings of culture as a hominid means of adaptation, this evidence only shows the application of implement-manufacturing techniques not much more sophisticated than those observed among chimpanzees to durable raw materials. As vehicles of information, the unevolved Oldowan lithics are extremely primitive. The very earliest stone implements may convey no more than two or three bits of information. The lack of information stems from a corresponding lack of system (regularity, pattern) in the artifact forms produced and the techniques used in their production. Until artifact attributes form consistent nonrandom patterns, noise blankets any meaningful information they may contain. The small degree of patterning represented in even later Oldowan artifact series may reflect limited behavioral control due to restrictions on the mental capacity of the toolmakers.

Due to considerations of preservation, the appearance of the first stone tools in the fossil record probably seems far more revolutionary to the prehistorian than it actually was. The fact that the first major expansion of hominids out of the African continent did not occur until perhaps two million years after the first stone tools are recorded supports the suggestion that the adaptive advantage they conveyed was quite minor.

At Olduvai Gorge, Oldowan occupations from Beds I and II exhibit obvious continuities in industrial characteristics: Developed Oldowan assemblages from Bed II are apparently somewhat more patterned versions of their early Oldowan predecessors in Bed I. Small proportions (about 6 percent of tools, on the average) of true handaxes, with no evident typological precursors in earlier horizons, are found in several Developed Oldowan (B) levels. Aside from this small increment of new types, the assemblages in question (BK II, TK II, SHK, FC West, MNK main) are homologous with other Developed Oldowan occurrences.

Classifying Developed Oldowan artifacts is only somewhat easier than is the case for early Oldowan pieces. Deliberate retouch is more regularly represented and often continuous enough to permit the recognition of a few major flake tool categories (scrapers, perforators, notches, burins, outils ecaillés). Multiple working edges are more common. However, neither the overall form of the flake employed nor that of the working edge is consistently classifiable into a manageable number of distinctive and regular groups. Variability is still the rule, and the large-tool series is no less variable than the flake tools.

There is no evident difference between the kinds of hominid activities attested for the Developed Oldowan levels and those suggested by the Early Oldowan sites. Relatively undisturbed Developed Oldowan occupation-residue scatters seem to be
quite restricted in size: on the order, say, of 20–30 square meters in area (although erosion has removed part of each). At the FC West living floor, bovids, equids, crocodiles, and hippos are the most frequent forms in the rare faunal series, with suids, tortoise, and elephant also noted. There is still no convincing evidence from any single site that the larger animals were deliberately hunted, but taken all together, the sites in Bed I and II indicate the regular exploitation of animals in a restricted region, and this is itself suggestive. The occurrence of large numbers of individual animals in some levels seems to hint at either deliberate or accidental animal drives. A “whole herd” of small antelopes (*Phenacotragus recki*) was found in one level at SHK (apparently not associated with tools). Natural phenomena, other than predator activity, which would account for such finds are hard to imagine. Even if hominids did not kill large game regularly, they at least scavenged it regularly, and of course, taking the smaller animals is well within the capacity of other higher primates. The ratio of artifacts to bone is higher in Bed II occupations than it was in Bed I, partly reflecting the more regular utilization of larger animals.

Proportional difference in artifact content between Developed Oldowan assemblages is sometimes quite marked, and the assemblages are more varied in content. Choppers no longer absolutely dominate the assemblages as they did in some Bed I occupations. These observations suggest that a process of artifact diversification and functional specialization was well begun. Some occupations have relatively large proportions of types represented rarely or not at all in other sites in Bed II. Probably the occupations themselves are beginning to be functionally specialized. Such systematic differences add at least one or two bits of additional information to the record.

One site in Bed II (EF/HR) has over 50 percent true bifaces, with few spheroids/subspheroids and no battered nodules or blocks (the latter two categories are relatively abundant in other Developed Oldowan occupations). The bifaces are extremely variable and hard to classify consistently. They are larger on the average than bifaces from other Bed II living floors. Mary Leakey has assigned the EF/HR assemblage to the Early Acheulean, claiming that the Acheulean and Oldowan represent “two distinct cultural traditions, perhaps made by two different groups of hominids” (M. Leakey 1971). It is clear that the distinction recognized is based in the last analysis on the large proportional representation of bifaces in the EF/HR collection more than on their morphology or other characteristics of the assemblage. In fact, in other respects the assemblage is quite similar to that from Developed Oldowan occupations. I rather believe that this kind of difference is more likely to reflect special artifact function and the specialized nature of tasks undertaken at EF/HR than a stylistic difference setting one hominid social group or evolutionary phylum off from another. As I see it, the Early Acheulean and Oldowan assemblages from Olduvai Gorge Beds I and II are as typologically similar as one can expect for a scanty sample from a single variable but completely continuous, evolving spectrum of lithic industrial development. The criteria which have been proposed at different times as indicative of the distinctive nature of the Acheulean are the presence of large proportions of bifacial tools, or the production of large flakes and their use in the fabrication of bifaces (M. Leakey 1971, 1975). But there do seem to be Developed
Oldowan bifaces on large flakes, which weakens the second criterion, and by the first criterion most well-excavated Acheulean sites from later time ranges would not themselves qualify as Acheulean.

Tools are known from two Australopithecine-bearing cave breccias in South Africa: Sterkfontein and Swartkrans (Mason 1962). Although there is no question about their association with the hominin deposits, excavation techniques have been crude at best—due to the indurated nature of the sediments (breccias). Mary Leakey calls both artifact series Developed Oldowan B (M. Leakey 1971); both contain crude and irregular bifaces in otherwise Oldowan-like contexts. The sites are interesting for two reasons. At Sterkfontein, the only hominin represented is the gracile Australopithecus africanus. Those who maintain that this Australopithecine was not a toolmaker have not convincingly explained this occurrence. At Swartkrans, remains of the robust Australopithecine were found in a pink breccia with bones of another hominin—Homo erectus (“Telanthropus”). Three cobbles from this site are said to be fire-spalled. If so, they are the earliest evidence for fire in a hominin site. In both cases, the presence of tools proves the recovered debris is in part, at least, the residue of hominin occupation, not just the remains of carnivore meals. Other, probably later “Developed Oldowan” assemblages are reported from the Melka Kontouré region (Ethiopia), Ubeidiya (Israel), and Ain Hanech (Algeria). Derived chopper/chopping tools are known in abundance from earlier Pleistocene geological deposits in Atlantic Morocco.

Assemblages with numerous bifaces are occasionally represented. At Peninj, two very early “Acheulean” horizons described in preliminary fashion by G. Isaac produced numerous, extremely “unpatterned” cleavers; the Peninj beds contained a mandible of the robust Australopithecine. The assemblages may be broadly contemporary with the Bed II Early Acheulean at Olduvai. Acheulean industrial development is well documented in Beds III and IV at Olduvai but as yet the occurrences are not fully reported and all may be disturbed. Homo erectus seems to be the author of some or most of these later assemblages.

RADIATION TO EURASIA

From the first appearance of convincing worked stones to the first spread of hominids out of the African continent a vast period of time intervened—at least 2 to 2.25 million years. The process of populating the usable African landmass seems to have been painfully slow, and our early hominid relatives must have found themselves precariously near the brink of extinction at many times. That they possessed an adaptive edge is clear from their eventual success, but the edge must have been infinitesimally small for hundreds of millennia.

Aside from one occurrence, which may still be problematical, there is no convincing evidence for population of Europe prior to the mid-Pleistocene. The exception is the Vallonnet cave on the coast of southeastern France. There, two choppers, three trimmed pebbles, two utilized or retouched flakes, and some debitage were found in deposits containing a Late Villafranchian fauna (Howell 1966; De Lumley,
Gagnière, Barral, and Pascal 1963). If the artifacts are not intrusive, they demonstrate an early and tenuous invasion of the European continent, an invasion which may have been ephemeral. Early man (*Homo erectus*) apparently first reached Southeast Asia late in the “Lower Pleistocene” (Poetjang beds, eastern Java). Nothing is known of his cultural inventory, nor are we better informed about the tools of his mid-Pleistocene Javanese descendants. From the paleoenvironmental evidence at hand, it seems that all these early sites except the Javanese occurrences were found in open country: stream banks, dry streambeds, lakeshores, and sea beaches seem to have been preferred localities. Probably such situations would have made game more visible to the hunters, and, where present, fresh water and succulent vegetation in the vicinity would have served to bring men and animals together. Even in the Javanese cases, where tropical forest predominated in the surrounding region, the hominid sites were in open micro-environmental settings. (It is even conceivable that regions of contemporary volcanic activity were especially favorable for the establishment of early hominid populations in the densely forested tropics.)

If evidence for a lower Pleistocene hominid radiation out of Africa is sporadic and tentative at best, Eurasian human occupation residues become quite common during and after the Elster glaciation. There is increasing evidence that the spread of hominids into Europe was a multipronged affair. Unlike as it may seem, one route of population spread crossed the Strait of Gibraltar from North Africa, probably moving northward along the Portuguese littoral to colonize the Iberian interior via the major east-west valley systems by late Elster times. The only other route may have proceeded around the Mediterranean coast, but from the evidence in hand there may have been a second Mediterranean crossing from the Eastern Maghreb to the Sicilian and Italian coasts, followed by a further spread up the Italian boot to the Riviera and France on the one hand and, perhaps, Central Europe on the other. The Pyrenees apparently constituted a major barrier to communication between France and Spain, since industrial development seems to have proceeded independently in each area for a very long time. On the other hand, the Mediterranean must have been a much less formidable barrier than we have suspected, since industrial complexes from Iberia and the Maghreb continued to be typologically so similar as to indicate continuous intraregional information exchange from Elster through Hengelo (Freeman 1975). For migration of most terrestrial organisms, the Strait of Gibraltar acts as a “sweepstakes route,” across which spread is highly improbable, although it does occasionally occur (Simpson 1962). However, from Elster on, the strait served as a readily traveled corridor for human movement (which probably proceeded in both directions after the first crossings). Strangely, there is no acceptable evidence for pre-Eem colonization of European Russia (Klein 1966). The arrival of early man in China, probably contemporary with Elster in Europe, is seemingly a continuation of the population radiation which established *Homo erectus* in Java during the lower Pleistocene.

The establishment in force of hominids on the European landmass is astonishingly sudden. Admittedly, our temporal discrimination for mid-Pleistocene events is very coarse, and occurrences separated by more than 10,000 years often appear
By their works you shall know them. However, compared with the snail-like pace of hominid expansion throughout Africa, the mid-Pleistocene radiation still must represent an exponential increase in rates of population growth. Man suddenly became tremendously successful.

We do not yet really know exactly what factors conferred the new adaptive advantage on early man. There is good evidence that all the colonists knew how to control fire, but there are strong suggestions that fire may have been utilized earlier. The migrants are all relatively large-brained, but new finds in East Africa suggest that cranial capacity among much earlier hominid groups may have been highly variable, and that at least the upper end of the range of variability overlapped with the later average (R. Leakey 1973). So far as we can tell, the toolkits of the earliest Europeans are not one whit more sophisticated than those of considerably earlier human groups in Africa. None of these factors seems an adequate explanation. In any case, the new adaptive advantage was almost certainly not conferred by any single sudden discovery or development, but a concatenation of increased capability in several domains. The kinds of change which would confer such an advantage without leaving direct durable traces in the tools men used or the shape of their bodies are basically of two sorts: more efficient organization of activities and increased efficiency in communication. The two are really sides of the same coin. An increased appreciation of the regularities of nature, better appreciation of the characteristics of the range, improved ability to predict when and where resources would be available, better scheduling of the exploitative round, sustained cooperation in the food quest, the avoidance of duplication of effort, and the capacity to respond to differential seasonal or local availability of resources by temporary segmentation or reaggregation of the social group are all factors which would be enhanced by (and some are absolutely dependent on) an ability to communicate complex information in unequivocal fashion which transcends any nonlinguistic signaling system not itself derived from articulate language. In my opinion, it was not the invention of new technological devices, but rather the ability to use available devices in innovative, better organized, and more efficient ways, which provided the essential advantage that ensured man’s spread. It seems likely that culture became a fully effective means of adaptation only in mid-Pleistocene times.

The effectiveness of culture as a major adaptive mechanism is mirrored in a further factor. Prior to the mid-Pleistocene, differing adaptations are reflected more in the variety of hominid body morphology than in cultural diversity. From the mid-Pleistocene on, there is no really convincing evidence that different hominid species were ever again sympatric. Hominid body form continued to respond adaptively, but the brunt of the process of articulating man and nature was thenceforth borne by culture.

Cultural Change Through Early Würm

Several mid-Pleistocene artifact series from Europe and Asia have recently been rather loosely referred to as a sort of attenuated Developed Oldowan. The collections in
question are sufficiently idiosyncratic to render that usage inadvisable. Probably one
should use local terms (Buda industry, Choukoutienian) to describe them.

The Elster (Biharian) occupation at Vértesszöllős is sited atop travertine-
calcareaous mud deposits of the ancient Atalér floodplain (Kretzoi and Vértes 1965).
The occupation layer is itself overlain by travertines and loess, the latter contain-
ing mammalian microfaunas indicative of full glacial conditions. During occupa-
tion, climate was more temperate and the regional setting was one of relatively ex-
tensive forest cover. Remains of larger mammals (primitive bovids, cervids, horses,
rhinos, bear, beaver, and wolf) are abundant and there are localized accumulations
of charred bone. Fragmentary remains of *Homo erectus* are associated. The more
than 2,500 lithic artifacts include diminutive choppers and chopping tools, notches,
perforators, scrapers, utilized and retouched flakes, *debitage*, and cores. While there
is still a marked degree of fuzziness at the limits of each apparent type, there seem
to be regular modes of attribute association—more regularity than in the Olduvai
Bed II Developed Oldowan. Several pieces have multiple working edges. Some very
tiny tools show carefully controlled retouch. No detailed faunal study or plan of the
spatial distribution of recovered materials is yet available.

Choukoutien Locality 13 and the Basal Gravel at Locality I provided three stone
artifacts in sediments apparently deposited under cold climatic conditions, which may
be contemporary with late Elster. The main hominid-bearing levels at Choukoutien
probably accumulated under interglacial conditions (Holstein equivalent?), to judge
from recent palynological and faunal studies (Hsu 1966; Kahlke 1968). The large
artifact series from the *Homo erectus* layers is made primarily of vein-quartz and
sandstone, which undoubtedly contributes to the crude and unpatterned appear-
ance of the industry. Choppers and chopping tools, scrapers, perforators, burins,
bolas, hammers, and battered cobbles are represented (Chia 1964). Several bones
bear conclusive evidence of deliberate human alteration (Breuil 1939). Evidence for
fire is abundant. Excavation techniques during the earlier exploitation of this over-
whelming (over 40 meters depth of deposits) site were totally inadequate to permit
meaningful socio-cultural interpretation (Black et al. 1933). Lithic artifacts are also
known from what seem to be somewhat earlier deposits (but perhaps still Holstein?)
in the Lantian area. They are much similar to the Choukoutien pieces. Although
they have not generally been recognized as such, there are rare bifacial implements
(mostly partial bifaces) in the Lantian mid-Pleistocene collections (Dai 1966; Dai and
Chi 1964). Information on these occurrences is still sketchy. The Asiatic cases offer,
in my opinion, the only possible potential examples of continued isolated cultural
development from an industrial base antedating the invention of bifaces, but I would
not be at all surprised if that proves not to have been the case.

Much fuller information comes from recent work at three early Acheulean sites
in Europe: Terra Amata on the French Riviera and Torralba and Ambrona in north-
central Spain. Human utilization of the Spanish sites took place during an Elster cold
phase. Torralba and Ambrona were located on the edges of a well-watered, marshy
valley dissecting the vast waterless uplands which divide the Ebro/Tajo drainages.
The local availability of water and succulent vegetation attracted large game in
considerable numbers. There are several levels of occupation at both sites, and the evidence from all is consistent; Torralba and Ambrona were butchering sites where animals were killed, and meat was processed prior to removal to as yet undiscovered living sites. Only large game was regularly taken (horses, cattle, rhinos, elephants, deer, reindeer, some carnivores). Hunting practices may be characterized, however, as opportunistic: no animal large enough to spot over the grass- and sedge-covered valley bottom was neglected. The evidence that different individuals from several species were killed, disarticulated, and butchered all at once suggests cooperation in periodic game drives and organized sharing of the product by cooperating social groups. Animals were driven into marshy situations where escape was difficult, and then dispatched and disarticulated on the spot. Certain favorable points near especially mucky spots or ponded water were chosen beforehand, and stockpiles of throwing stones, and probably some finished tools and raw material, were deliberately accumulated near these natural traps. Game was repeatedly driven to the same preselected kill sites. (Fire-drives may have been seasonally practicable.) The mired animals were stoned, burnt, or speared, and disjointed where they fell. Each of the several participating social units received a portion of every animal killed. The social units sat apart from one another to finish the preliminary processing of their booty, and then carried off the choice product to their living areas. Only the undesirable residues of carcasses were left behind. Tools were left where they were used, probably because the prehistoric hunters intended to return and reuse them in the not-too-distant future. As many as seven social units, each of them probably composed of several (5–7?) individuals, evidently shared in tasks performed in some Torralba levels, and the amounts of meat carried away must have been formidable (up to 9,000 kilos) to judge from the number of animals represented and the proportions of their skeletons which are missing (all the meatier body parts were carried away). Cooperation in the extensive game drives attested and carrying away anything like this quantity of meat would have required substantial numbers of able-bodied participants. The larger social group from which the hunters came may have numbered over a hundred individuals, and although such large population aggregates might have been feasible only from time to time, all could have used a single encampment during the periodic hunts.

The tools used by Torralba hunters were no more sophisticated than those known from Africa at a comparable period. Using multivariate statistics, the analysts have been able to discern a number of activity-specific toolkits, each of which was used to perform a restricted set of operations related to the butchering process. Differentiation of artifact function is very marked—there are few truly general-purpose tools (by the way, these do not include bifaces, which at Torralba were used to batter open the robustly buttressed skulls of elephants and wild oxen). Heavy-duty flensing and boning were done with one set of equipment, fine slicing with another, the butchering of large skulls with yet another, and so on. Each of the attested activities was performed in a different area.

Most of the recovered implements are flake tools, and there is considerable typological variety in the collection. There are quite numerous multiple-edged arti-
facts, but there is no significant tendency for given different types to be combined. The overall shape of the flake tools is not tightly standardized, but the shape and size of retouched working edges is much more so. Bifacial tools are quite rare (they are entirely absent from one Torralba Acheulean level). There is no evident "stylistic" difference between the artifacts produced by Torralba hunters and those produced by the Ambrona groups. In fact, both collections are virtually indistinguishable from North African Acheulean artifact series of comparable age. Worked wood (including a slim spearpoint) and bone are also represented in the Torralba artifact series. Evidence for the use of fire is abundant, but no true hearths were found. The sediments occasionally contain small bits of ochre and one large fragment from Ambrona seems to have been worked (Freeman 1975, 1978; Freeman and Butzer 1966).

The sophistication of scheduling and organization of hunting and meat-processing activities evidenced by the regularities in the Torralba/Ambrona data are such that it is inconceivable that they could have been sustained without language. While no structural remnants were represented at Torralba or Ambrona, there is good evidence for the construction of at least temporary shelters in several levels at Terra Amata—stone walls, postholes, and stone rings that may have hedged the bases of other posts form oval patterns that may outline huts. True hearths occur. The site is probably a temporary (warm-season?) base camp, on a bay near the mouth of a small river. The artifact inventory contains numerous choppers and chopping tools, but is clearly Acheulean, with partial bifaces and picks also represented (De Lumley 1966). Strangely, there is no evidence for particular attention to strictly coastal resources at Terra Amata or any other Early or Middle Acheulean site, although the littoral was clearly utilized.

The evidence from these early sites prefigures developments throughout the long period from Elster through early Würm. All the well-excavated sites are interpretable as variations on a single adaptive leitmotif, in my opinion. Throughout this lengthy period, man managed quite well as an opportunistic hunter/gatherer. Apparently his techniques and organization were highly successful, but little experimentation with tried-and-true methods seems to have been tolerated. A close examination of large numbers of single artifact types from one occupation shows each to have encompassed substantial variability—a simple convex sidescraper, for example, may be longer or shorter, steeper or flatter, more or less convex, made on a lateral flake margin or a wide extremity, yet it is still demonstrably the same. If tools of the same type, but from sites thousands of miles from the first, are added to the collection, variability does not increase in any systematic way. The raw material used in the new group may exert its influence, but otherwise we could probably lose the second group in the first. There are interregional boundaries, like the Pyrenees, across which notable differences in artifact inventory can be discerned, but the size of the areas in which artifact series are homologous at any given time is remarkable. The fact that artifact types from a single site are internally quite variable, while the ranges of variation within a given type from different sites in a wide region overlap, largely indicates that there is little or no deliberate stylistic information imposed on the stone tools. Nor is there the sort of unconscious stylistic load that is often incorporated in
the products of distinct modern identity-conscious socio-cultural groups. While this may simply be accidental, since it is not easy to alter lithic artifacts without affecting their functions, it may reflect an adaptive reality. Conceivably, intergroup boundaries were not as purposefully maintained, signaled, and defended as they are among most modern societies. The distinction of “we” from “they” may have been adaptively dysfunctional as long as human groups were small and resources abundant. Appropriate mates would be hard for an adult to find in a coresident group whose maximum numbers were only on the order of 100 people (or less) of all ages. Open group boundaries might have lessened the tensions of contact between social units, facilitating intergroup movements of personnel; the occasions for such movement might have been regular and formalized (periodic aggregations of large numbers in a restricted area) or unpredictable and informal, occurring at chance encounters. In either case, permeability of group boundaries might have been quite advantageous to survival. Idiosyncratic attributes which may characterize the artifacts from more restricted regions begin to appear only in the Middle Paleolithic but even then they are almost certainly not the result of deliberate stylistic differentiation.

Formal differentiation and functional specialization of artifact types proceed gradually throughout the Lower and Middle Paleolithic period. The absolute number of different tool types the analyst may recognize varies directly with the total number of shaped tools recovered (probably this partly reflects the fact that the number of discrete tasks performed by prehistoric men at a locality varied directly with the intensity of occupation; partly it reflects sampling effects). As a general rule, the total number of different types in Oldowan and earlier Developed Oldowan assemblages varied as the square root of total shaped tools recovered. For earlier Acheulean assemblages, the number of distinct types is about 1.5 times the square root of total shaped tools, and by the end of the Acheulean, the figure is on the order of two and a half times the square root, an average figure which, incidentally, is only very rarely exceeded during the rest of the Paleolithic.

Formal differentiation of artifact types seems to have occurred as the result of gradual, cumulative, and probably almost imperceptible incremental changes due to cultural drift. There were no obviously revolutionary inventions or drastic innovations—the course of overall change seems smooth. Retouch, which covers both surfaces of bifacial implements, becomes more regular, finer, and obviously better controlled. All the basic elements needed to maximize the potential of lithic artifacts as information channels are present by the late Acheulean except the regular use of pressure flaking and the punch-driven blade technique. Masterful implements were being made on very small blanks, where necessary to economize raw material. On the other hand, where raw material was abundant in large sizes, a prefiguration of modern mass production techniques, Levallois flaking, had appeared. Levallois technique ensures the serial production of several analogous implements from a single specially prepared core with a minimum number of flaking operations. Conservative of energy, the technique can be relatively wasteful of raw material.

Bone and wooden artifacts are preserved with some frequency despite their perishable nature. At Kalambo falls, wooden clubs and possible digging sticks were
recovered from Acheulean contexts. Some Mousterian occupations (Morín and el Pendo, in Cantabrian Spain) show that the techniques acquired for stoneknapping could be successfully applied to bone to produce a wide range of handsome flaked implements (González Echegaray, Freeman et al. 1971, 1973). The first tentative experiments in engraving bone occur in Acheulean and Mousterian contexts.

Until Early Würm the evolution of artifact morphology reflects continued design improvements which make working edges and whole tools more efficient for use in a small number of primary operations. Adaptations reflected in the artifact inventory may be called “technique-oriented.” Slicing tools become more efficient as slicers, crushing tools become better suited for crushing; each implement type becomes better adapted to a specific kind of manipulation. The primary operations in question may be performed on a variety of materials: skins, vegetable fibers, wood, and meat can all be sliced with the same cutting edge. There is no evidence that any tool was specially tailored to work on one material alone. Naturally, if artifact design is not immediately related to the specific resources manipulated, artifact series will provide little reflection of major environmental difference. At a butchering site, a cleaver might be used to batter open an elephant skull; the same cleaver might later be used to chop down a tree, to split open large bones, etc. Because the specific nature of the manipulated raw material is irrelevant to cleaver design, cleavers in cold temperate environments could be formally identical to cleavers from hot savanna or tropical river valleys. This observation is probably the key to understanding why widely separated Lower and Middle Paleolithic artifact assemblages may look so similar.

As time goes on, the differentiation of activities within single occupations becomes increasingly easier to discern. Different tasks are done in different places, and with some frequency activity-specific areas are set off from each other structurally. Dry walls divide cave interiors into two or more compartments. Convincing dwelling remnants are preserved at several Late Acheulean and Mousterian sites. Hearths, pits, postholes, and mounds are features known from many later (especially Mousterian) sites. Some small pits seem to be food-storage facilities. The differentiation of areas within single occupations is paralleled by a clearer functional differentiation of distinct occupations. It seems possible that differences between Clactonian and Acheulean sites or between some Mousterian facies are activity related rather than stylistic. Specialized quarry/workshop sites, hunting/butchering camps, and base camp/living sites are well defined even in the Lower Paleolithic.

Towards the end of the period, there is evidence that some sites in favorable localities were occupied year-round. That is true, for example, for some Mousterian sites in France and northern Spain. In the Spanish case, where resources were probably available all year round, this was accomplished by locating the base camp at a central point with respect to the distribution of exploited resources, but it would not have been feasible without long-term storage in areas characterized by marked seasonal scarcity (Freeman 1973). Opportunistic exploitative strategies were universally the rule; occasionally, hunters managed to trap and kill large numbers of animals of a single species, probably by accident. But in no case is regular reliance on a narrow range of productive resources attested.
We know that some Acheulean and many Mousterian groups made deliberate use of coloring material—worn-down “crayons” of mineral color are frequent finds. However, we do not know what was being decorated. Aside from a few enigmatic engraved doodles on bone, no Lower or Middle Paleolithic artistic productions survive.

For thousands of millennia, the hominid dead were apparently ignored or disposed of with other garbage. The first evidence for the separation of the bodies of deceased men from those of animals and from food debris appears in Middle Paleolithic contexts. The treatment of Neandertal dead at sites like Teshik-Tash, Shanidar, and La Ferrassie involves ceremonial complexities which are already highly elaborated—bodies are interred in specially prepared graves capped in some cases by visible mounds, and mortuary offerings, which may include food, flowers, and/or the tools essential for daily survival, are included with the remains. Most authorities agree that the authors of these reverential ritual practices are morphologically members of our own species, although there are still a few who advocate specific distinctions between Neandertals and modern men. Certainly the complexities of behavior evinced by this evidence hint at belief systems so elaborate as to fall within the range for fully modern men.

While cultural change is a slow and gradual process, the rate of replacement of given artifact types and industrial complexes seems to have accelerated geometrically. The Oldowan may have lasted 2 million years, the earlier Acheulean a million or so, the Middle and Late Acheulean perhaps three to five hundred thousand together, and the Middle Paleolithic industries less than a hundred thousand. While one generally gets the impression that Lower and Middle Paleolithic industrial evolution was nearly stagnant, that is only because continued acceleration at essentially similar rates resulted in strikingly rapid industrial succession during the Upper Paleolithic, so that earlier developments seem slow by comparison.

**ACCELERATED CHANGE IN THE LATEST UPPER PLEISTOCENE**

A great deal of importance has been attached to the advent of anatomically modern man and its supposed correlate, the appearance of blade and burin industries. In fact neither of these factors had as revolutionary effects as is usually supposed. As a result of continued formal and functional differentiation of lithic artifact series, prefigurations of the early Upper Paleolithic blade/burin industries had sporadically occurred in North Africa and Southwest Asia long before Hengelo, but without any devastating and long-lasting result. However, the tempo of industrial replacement had become many times faster than it was in the Lower and Middle Paleolithic, and this contributes a misleadingly revolutionary allure to the Upper Paleolithic.

In fact, earlier Upper Paleolithic adaptations were not noticeably different from those documented for the Middle Paleolithic, and opportunistic exploitative strategies continued to be the rule. While treatment of raw material and flaking techniques in earliest Upper Paleolithic (Chatelperronian) contexts in Europe dif-
fer appreciably from those common earlier, there are nonetheless marked continu-
ities between Mousterian and Chatelperronian artifact types (González Echegaray,
Freeman et al. 1971, 1973). Similar continuities are noted for the transition from
"Middle” to “Upper” Paleolithic complexes in Southwest Asia. However, with
time some important developments do occur which distinguish Upper Paleolithic
adaptations.

Even during the Middle Paleolithic, suitable living areas were gradually being
filled by human populations, although density remained well below the carrying ca-
pacity of the area. By the Upper Paleolithic, man had learned to exploit the northern
steppe and perhaps the tropical forest as well. As populations increased, the exploita-
tion of locally available resources intensified and diversified. Shellfish, present only
occasionally in Middle Paleolithic sites, began to be utilized more extensively. More
small animals were taken. Some creatures had been neglected by some communities
during the Middle Paleolithic, seemingly because their exploitation was dangerous or
too costly to warrant the necessary expenditure of time and effort. Upper Paleolithic
peoples found it necessary or desirable to collect those creatures. Nocturnal burrow-
dwelling fur-bearers are regularly represented in Upper Paleolithic occupations for
the first time. Their presence almost certainly shows that their hunters were em-
ploying self-acting devices (traps, snares) to take them. The first evidence for the
construction of pitfalls, the pitfield at Les Trappes in the Dordogne, is probably
Upper Paleolithic in age. Perhaps certain small fur-bearers were hunted exclusively
for their pelts. All lines of evidence indicate an increasing awareness of the potential
regionally available resources and the development of means for their acquisition
(Freeman 1973). To be effective, many of the new devices had to be designed specifi-
cally for use on one particular resource (as is the case for certain traps, fishhooks,
weapon points, nets, and so on). Upper Paleolithic industries are characterized by a
shift from “technique-oriented” adaptations to “regional- and resource-oriented” ad-
aptations. As an inevitable consequence, the tools used in one small region are often
quite distinct from those used in another. The process of interregional differentia-
tion proceeded quite rapidly, so that by about 18,000 BC, Solutrean weapon points
from one small river valley can easily be distinguished from the points made just a
few kilometers away. Probably some of the differences noted are conscious stylistic
devices that set off the product of one identity-conscious socio-cultural group from
that of another.

Conclusive evidence for the presence of multicomponent composite tools is
also first documented during the Upper Paleolithic. Some of the new tools are so-
phisticated devices conferring considerable mechanical advantage. True arrowheads
may exist in North African Aterian collections, and they are certainly present in the
Levantine Solutrean (Parpalló, Ambrosio). Composite foreshafts for Magdalenian
weapons have been preserved, still in connection. Spearthrowers characterize
Magdalenian collections. Microliths designed for hafting as points and edges of
composite darts or spears are also documented. The information carried by these
new channels is often infinitely multiplied by nonfunctional decoration of their sur-
faces. The common presence of bone implements in Aurignacian, Solutrean, and
Magdalenian artifact inventories provided an abundant and relatively easily decorated medium for artistic expression. Crude baked-clay figurines are known from Eastern Europe. Some of the engravings on Upper Paleolithic bone implements seem to be a sort of notation, but certainly not all the tally-marked bones are lunar calendars, as has been suggested.

Artistic representations are commonplace parts of the European Upper Paleolithic inventory (Ucko and Rosenfeld 1967), and masterful engravings, paintings, and sculptures are known from portable objects or the walls of the caves sometimes used by prehistoric men. These representations give us a vivid glimpse of the animals men hunted and sometimes of the men themselves. The potential of these representations for stylistic analysis has not yet been realized. Their study could indicate the spatial position of social group boundaries in the prehistoric past, and tell us a good deal about socialization practices. Their quality probably also indicates the presence of at least part-time craft specialists.

Standardization of artifacts reached a peak during Upper Paleolithic times. From some Solutrean levels we have laurel- and willow-leaf points that are almost exact duplicates in size and shape. The same is true for some Magdalenian bone harpoons. Unprecedented control was being exerted over morphological and metrical attributes of these implements.

An impressive variety of storage facilities is known from Upper Paleolithic occupations. These vary in shape as well as size, and some pits show evidence of heat treatment to harden their walls against rodent and insect penetration. Structures are also variable. Large elongate surface buildings, small square and round ones, pavements, rings of stones or bones marking former tent emplacements, and semi-subterranean structures are known. There was apparently much variability in the internal appointments of these dwellings and in the management of internal space, characteristics which should correlate to some degree with the size and organization of the group of occupants. While some sites were probably occupied by very small social units, other large sites (especially caves) may have sheltered great numbers at least on a periodic basis. That seems to be the case for some of the larger decorated “sanctuaries,” which probably were used as major ceremonial centers serving all the people from an extensive region. These differences in site size and arrangements are certainly correlated with major differences in social organization during the latest Pleistocene.

There are some suggestions of status differentiation within Upper Paleolithic societies, especially in the differential treatment of the dead. However, in every case the burial sample is very small, and these suggestions may be misleading. A few graves do include great numbers of beads or other personal adornment. Possibly some Solutrean laurel leaf points, apparently too delicate to have been used as tools, may have served as badges of rank, but, once more, there is no conclusive evidence on the subject.

Networks of long-distance trade are attested by the occurrence of goods transported over great distances in some Upper Paleolithic levels. Perforated Mediterranean shells are found in Atlantic Europe; alien raw material has been used to make
tools in sites hundreds of miles away from the source. Data at hand are still insufficient to permit real understanding of the nature of these networks.

Strangely, the total number of artifact types recovered from any given Upper Paleolithic occupation is seldom greater than that from Middle Paleolithic occurrences, given collections of comparable size. The average number of types remains about 2.5 times the square root of total retouched tools. But the Upper Paleolithic as a whole seems characterized by far greater diversity, because of the great rapidity of industrial turnover. The European Upper Paleolithic in its entirety only spans about 25,000 years, and the whole temporal duration of the Magdalenian in all its manifestations is only about 6,000 years.

By the end of the Upper Paleolithic, industries are so well patterned and the behavior reflected in the occupation residues is so apparently understandable that the analyst must constantly fight a tendency to regard the authors of the industries as in every way like himself. They seem so similar to us that it is dangerously tempting to believe that they thought about themselves and the universe in our terms, and that our experiences must be identical. Of course, they are nothing of the sort, and that sort of reasoning will not lead to valid conclusions about the prehistoric past. Nevertheless, the conclusion is inescapable that their behavior was as intricate and sophisticated as our own, and that they were completely modern in all important senses.

The single most important step in cultural development during the Upper Paleolithic occurred sometime between 18,000 and 14,000 BC. It was a major shift in exploitative strategies which came as a logical culmination of earlier adaptations. Instead of reliance on a diversity of subsistence resources, the new strategy entailed intimate and intensive concentration on a very few especially productive wild resources (Freeman 1973). Those resources were regularly cropped, intensively enough so that they would maintain a high rate of increase but not so intensively as to exhaust them. In Cantabrian Spain, this shift to “wild-harvesting” came with the Lower Magdalenian. The resources chosen were red deer, winkles, limpets, and snails. Many red deer were harvested at once from the local populations, probably by massive game drives, taking advantage of the fact that local deep cover during the height of the glacial cold was broken up into small isolated stands. Some Lower Magdalenian sites contain no mammal bone but red deer, and in tremendous quantities (50+ individuals) at that. In France, reindeer and horses may have been harvested in this way. Shellfish may have been the mainstay of diet, seasonally. Shifting site location reflects the new exploitative strategies, with some sites located on the coasts for easy access to limpets and winkles, and others at the edge of the uplands, close to alpine mammals, in regions where *Helix* could be collected in abundance. Probably there was a seasonal alternation between the highland (summer?) and coastal (winter?) sites. Exploitation of the limpet (*Patella vulgata*) soon eliminated the older and larger individuals entirely from the natural populations: Magdalenian sites no longer yield the large specimens common in earlier levels. Below a certain minimum size, limpets do not yield enough meat to make their collection by normal methods rewarding or even feasible. Yet in Azilian and Asturian levels, many individual specimens below this minimal size are represented (de la Vega del Sella 1923).
conclusion seems inescapable that wild-harvesting had been carried one step further by the immediately post-Pleistocene hunter-gatherers. As far as I am aware, the only practical way to collect such small specimens in any quantity is to cultivate them deliberately. Masses of seaweed, nets, or frames of stakes and branches can be located in the supralittoral and intertidal zones frequented by the molluscs; their spawn, collected on an artificial substrate, can be stripped from it periodically and the cycle started anew. The suggestion that any preagricultural group may have known how to cultivate a natural resource seems daring, but, after all, the suggestion requires behavior little more sophisticated than that involved in repeated wild-harvesting of any kind, and the evidence that wild resources were periodically harvested by at least some late Upper Paleolithic communities is absolutely incontrovertible.

### SUMMARY

While stone tools in and of themselves offer but a pale reflection of prehistoric hominid capacity, an examination of all the many categories of evidence preserved in well excavated, intact occupation floors affords a more meaningful approach to the understanding of prehistoric lifeways. Few suitable well-studied occurrences are available, but an examination of the meager evidence in hand forces a reevaluation of tenets we have tended to regard as having almost the force of revelation.

The difference between man and his primate relatives is certainly a quantitative rather than a qualitative one. Man possesses no mystical attributes, “symbolic capacity” or whatever else they may be called, which create any great gulf between him and “non-humans.” The road to man’s present state was long, rough, and steep and required much effort in the traveling.

The invention of stone tools marked no drastic revolution in the hominid condition. Our forebears were little more than clever apes; the difference between their abilities and those of modern chimpanzees was relatively minor. Tools alone did not make man as we now know him; he is the result of a multifaceted adaptive process. The hominid adaptive commitment involved an ability to learn to manufacture extensions of the body, their production and utilization in organized social contexts, and communication, and it is impossible to separate these factors. Several ways of being “human” were tried at first, and those that failed probably did so because of an inability to communicate or to coexist effectively, or an inability to articulate the processes, not because people could not make effective implements. One of the important observations that can be made from the study of both the past and the present is that there has never been any direct, one-to-one, correlation between hominid physical type and “culture.” Extinct hominid species evidently made and used artifacts of the same kinds as those produced by their adaptively successful contemporaries.

At one time, the prehistoric record as we understood it was full of apparent “revolutions”—the Urban Revolution, the Food-Producing Revolution, and the Blade-and-Burin Revolution are familiar examples. With closer scrutiny and more information each of these revolutions has tended to evaporate into thin air. And that is understandable. There are no revolutions in prehistory; there is only adapta-
tion—the continuous and gradual readjustment of organisms to constantly changing ecosystems.

Man’s cultural beginnings were small and feeble, but they provided the means of attaining an immense adaptive advantage. The transmission of learned behavior is much more rapid than the transmission of genetic material. Information acquired as the result of a new experience can be passed on immediately to other members of society. Through the continuing socialization process, man’s evolution has become Lamarckian, in a sense. In culture, man “inherits” acquired characteristics. As a result, fully effective cultural systems allow great flexibility and rapidity of response to changed circumstances. But, for a long time this potential was not recognized. While socialization processes were still relatively difficult, communication still rather rudimentary, and noise very high, it was a safer strategy to concentrate on conveying a limited amount of easily understood information which would be generally applicable regardless of circumstances. As long as hominids were scarce, the opportunity for contact with individuals whose experience was widely different from one’s own must also have been extremely limited, and short lifetimes would tend to remove from society those older individuals whose experience was greatest. As a result, the potential variety of information available through socialization in any given community was normally very small. The cultural means of adaptation nonetheless was advantageous.

Gradually, humanity spread and filled the most suitable land areas of Africa and Eurasia. Gradually, ability to communicate and to organize activities became more efficient. By the mid-Pleistocene, occupation complexities suggest advanced communication techniques and highly efficient organization for exploitation. As population grew and interpersonal and intergroup encounters became more frequent, the variety of available information increased. Culture change, so slow before, accelerated at a geometric rate. Each successive major industrial complex lasted only about half as long as its predecessor. Probably that exponential rate of acceleration remained constant until the invention of writing. The Upper Paleolithic marks no revolutionary break in the acceleration rate, just its natural continuation. By 30,000 years ago, the turnover of industrial complexes had become so rapid as to appear to mark a radical break with the past, but that is simply an illusion.

Judging from the abundant artistic representations and decorative motifs in Upper Paleolithic contexts, and from the presence of systems of notation, it is clear that the capacity of late Paleolithic man was as well developed as our own. And, in fact, by the end of the Pleistocene, man was already experimenting in controlling a variety of natural resources in ways which would have preadapted him for the development of agriculture and animal husbandry. All that remained was the discovery of those resources with the greatest potential for domestication and exploitation. The development of agriculture in the Near East and Asia must be considered as basically no more than happy local results of the application of techniques which were probably being tried with varying success over much of the habitable world. Paleolithic developments thus prefigure essentially all the basic elements on which were based the development of agriculture, urban life, and, indirectly, the modern industrial civilizations.
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The original aspects of this chapter are speculative enough so that they may seem somewhat controversial, especially since I was not able to examine all the artifact collections I have discussed at first hand. Nonetheless, I am encouraged by a statement made by K. P. Oakley, in a paper (1968) on the same subject: “If one is embarking on a speculative hypothesis at all, one may as well be thorough going!” I thank the editors for having permitted me to do so.

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