Gesture and Speech

ANDRÉ LEROI-GOURHAN

translated from the French by Anna Bostock Berger
and introduced by Randall White

An OCTOBER *Book*

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Introduction

RANDALL WHITE

My goal, in this brief introduction to the first English translation of *Le Geste et la parole*, is to present André Leroi-Gourhan (1911–1986) posthumously to a broad American scholarly audience, and through a work written thirty years ago. This might seem a curious objective in that some of my American colleagues undoubtedly presume, as did I until recently, that they have a thorough knowledge of Leroi-Gourhan and his work. This putative knowledge, however, is based primarily on the few fragments of Leroi-Gourhan's massive *oeuvre* that have been published in English, notably the English translation of his *Préhistoire de l'art occidental* (trivialized to *Treasures of Prehistoric Art*), published one year after *Le Geste et la parole* and representing a theoretical and methodological outgrowth from it.[1]

On the basis of this fragmentary and highly selective sample of his work, Leroi-Gourhan remains a paradox to some American scholars and merely a conventional structuralist to others. That is, in the eyes of ecologically oriented American anthropologists of the 1970s, Leroi-Gourhan was viewed as an "art" researcher who sought to know the unknowable or, worse yet, what they perceived as the evolutionarily insignificant. The paradox arrives out of the recognition that simultaneously Leroi-Gourhan's excavations at the 11,000-year-old Magdalenian campsite of Pincevent generated an unsurpassed knowledge of the technology and material organization of an ancient people. It is the fault of the limited literature available in English, and of monolingual scholarship, that this paradox, which does not exist in *Le Geste et la parole*, has never truly been resolved for us Americans.

1. Notably in recent years Annette Michelson has undertaken the publication of translations of two articles on cave art, but the work available in English remains totally nonrepresentative. It is telling that Leroi-Gourhan's most widely cited English work is a 1968 *Scientific American* piece on the evolution of Paleolithic art.

Those who view him as a rather conventional structuralist point to *Treasures of Prehistoric Art* and argue that he completely decontextualized and dehistoricized visual representation in the Upper Paleolithic. He allegedly did this by treating 25,000 years of cave and portable art as if it were a unitary cultural phenomenon, and then searching for structure within it. Proponents of this and the previously noted "art as evolutionarily unimportant" perspective dutifully scoff at Leroi-Gourhan's interpretation of complementary oppositions in cave art as reflective of a gender-based world view (for example, bison = male, horse = female). In jumping on this conventional bandwagon, few authors know or choose to mention that Leroi-Gourhan completely abandoned this interpretation in the late 1970s.

The criticism that Leroi-Gourhan showed little concern for chronologically and culturally contextualizing Paleolithic art is puzzling, particularly since much of *Treasures of Prehistoric Art* is dedicated to the construction of a style-based chronology of Paleolithic art. While this chronology is wholly problematic on a number of grounds, it reflects a full awareness on Leroi-Gourhan's part of the need for chronological attribution of works before they could serve as a basis for analysis. Indeed his excavations at Pincevent sought explicitly to expand our understanding of the social and material existence of late Ice Age peole in the France of 11,000 years ago.

It is my premise here that Leroi-Gourhan was neither a formulaic structuralist nor a paradox. These views of Leroi-Gourhan result from a certain hostility in America to structuralism and an almost total ignorance of his preceding landmark works in which he constructed a synthetic model of human thought, communication, and action. *Treasures of Prehistoric Art* and the excavations at Pincevent ought to be seen merely as parallel logical consequences of an evolutionary theoretical model that is thoroughly developed in *Le Geste et la parole*. One must therefore read this work in order to grasp the theoretical foundation of what followed in Leroi-Gourhan's own work, in French prehistoric archaeology in general, and in certain elements of post-structuralist theory (notably the emphasis on praxis).

But even before *Le Geste et la parole*, Leroi-Gourhan's biography and bibliography were truly remarkable.[2] No French prehistorian before him (and few if any since) was so broadly trained and practiced in ethnology, physical anthropology, archaeology, and linguistics. In 1929 he became a voluntary librarian in the newly reorganized Musée d'Ethnographie de Trocadero, under the directorship of Paul Rivet who chose to dedicate his chair to "the Ethnology of Modern and Fossil

2. Much of the biographical detail presented here has been derived from Gilles Gaucher's 1987 biographical article in the special issue of the *Bulletin de la Société Préhistoriques Française* 84(10–12):302–315.

Humans."[3] Thus Leroi-Gourhan was present during the dynamic transformation of the old Trocadero Museum into the Musée de l'Homme (officially in 1937) and was apparently heavily influenced by the experience. Even as an adjunct volunteer he was given responsibility for the Far East and for the Arctic.

His first degree (1931) was in Russian, followed by another in Chinese (1933). He then studied for the "Certificat d'Ethnologie," a program established by Marcel Mauss and Paul Rivet in 1927. This put him in contact with the great names of French ethnology, including Marcel Griaule, Michel Leiris, Claude Lévi-Strauss, and Jacques Soustelle. An extended period of research in the Department of Ethnology at the British Museum in 1933–34 reaffirmed a previously unfulfilled interest in technology: "This prolonged immersion in English museums, with exposure to Egyptian sculpture, Chinese ceramics, oriental carpets and steam engines crystallized all of my latent tendencies."[4] By the time his first two books were published in 1936, he had already begun to collect data on technology around the world. Both of these books, *Bestiarie du bronze chinois* and *La Civilization du renne*, reveal his interest in techniques and material culture as cultural expressions every bit as meaningful as linguistic utterances.

In the same year Leroi-Gourhan headed to Japan on a two-year ethnological research and collecting mission. This research, which included work among the Ainu, was truncated by the impending hostilities that would ultimately lead to the outbreak of war. Nevertheless, it was during this mission that Leroi-Gourhan undertook his first archaeological excavations. Upon his return to France, he was made a member of the newly formed Centre National de la Recherche Scientifique (CNRS). Between 1940 and 1945 he prepared and published one of his most important works, *Évolution et techniques*, which remains virtually unknown in America. This enormous work, published in two volumes (*L'Homme et la matière* in 1943 and *Milieu et techniques* in 1945), is a systematic and enduring cross-cultural synthesis of human technology.

In 1944 he finished his Thèse de lettres, *Archéologie du Pacifique Nord* (published in 1945). His complementary thesis was entitled *Documents pour l'art comparé de l'Eurasie septentrionale*. This work sensitized him to a lack of cross-cultural correspondence between form and meaning in material representation. He was thus led to distinguish explicitly in his analysis of Paleolithic art between recurrent associations of certain symbols, on the one hand, and the ideology behind the repre-

3. Quoted in Gaucher, op. cit., p. 303.
4. Ibid.

sentations, on the other. For him this ideology (or meaning) was probably unknowable and was specific to time period and place. This critical distinction between knowable formal patterning and unknowable meaning of constituent symbols has, in my opinion, been ignored by most of Leroi-Gourhan's English-speaking critics who have not had access to the detailed theoretical statements presented in *Le Geste et la parole.*

In 1946 Rivet, now director of the Musée de l'Homme, named Leroi-Gourhan assistant director of the museum. Shortly thereafter another young ethnologist, Claude Lévi-Strauss, would be named as the other assistant director. While Lévi-Strauss would gain worldwide recognition for applying a linguistic-structuralist model to sociocultural phenomena, Leroi-Gourhan would do the same for material culture.

Leroi-Gourhan's responsibilities involved the teaching of ethnographic techniques and museology. While, he argued, ethnology was doable in France, it was mostly usurped by other disciplines. As a result he emphasized *palethnologie* and established archaeological field training for students, notably at Arcy-sur-Cure, a rich locality of Mousterian and early Upper Paleolithic occupations. In this context he was a champion of broad-scale excavations that treated archaeological sites as spatially complex human occupations. He was among the first in Western Europe to ask ethnological questions of archaeological sites, and such questions could not be answered by old pick-and-shovel techniques. A major theme of his teaching was that even the most concrete aspects of technology contributed to more general ethnographic understanding. In other words, the analysis of items of technology is tied directly to an understanding of social structures and belief systems.

At the same time as the above endeavors, Leroi-Gourhan was exploring yet another domain relevant to an evolutionary understanding of human action and communication. In 1954 he defended a thesis entitled *Les Tracés d'equilibre mécanique du crane des vertébrés terrestres* (Patterns of mechanical equilibrium in terrestrial mammals), finally published thirty years later. This very original work served as the basis for much of the first part of *Le Geste et la parole* in which Leroi-Gourhan argues that early hominid increase in brain volume was driven by structural changes associated with bipedalism. This part of the present volume must be understood as a critique of those who see brain evolution as an independent prime mover. In essence, bipedalism stimulated an entire suite of evolutionary developments: changes in brain size and organization that had evolutionary implications for language and cognition; release of the face from feeding and manipulative functions, thereby allowing structural specializations for speech; freeing of the forelimbs from locomotor functions, thereby allowing them to be used in tool production.

Thus by the 1950s[5] Leroi-Gourhan had constructed

- a sophisticated theory of hominid biocultural evolution;
- a profound and systematic understanding of the complex range of known human technologies;
- a strong commitment to technology as *the* point of access for understanding human cultures and to technical activities (both past and present) as instrumental, communicative, symbolic, and culturally constructed;
- a skepticism concerning our ability to understand the meaning of specific ancient representations;
- a strong immersion in French structuralist thinking;
- a view of "art" based in a sophisticated understanding of cultural aesthetics (indeed Leroi-Gourhan systematically talked of representation and seldom used the term "art");
- a set of meticulous methods for excavating and studying the prehistoric record.

In retrospect these intertwined aspects of Leroi-Gourhan's own thought and action seem to imply a systematic attempt by a brilliant mind to assemble all the components necessary to a kind of "unified theory" of human biocultural evolution. *Le Geste et la parole*, published in 1964, was the realization of that attempt.

Having established the trajectory and intellectual context that led to *Le Geste et la parole*, I wish now to explore in detail the originality and prescience of Leroi-Gourhan's contribution to a social scientific and evolutionary understanding of technology and of symbolic representation. I will then conclude with a balanced assessment of the general strengths and weaknesses of *Gesture and Speech* and some warnings about sections of the present volume that are empirically outdated, although these are remarkably few.

For most English-language readers the concept of "gesture" will seem a curious one to emphasize. It should probably be glossed as "material action," as it refers

5. During this decade Leroi-Gourhan's thinking on the subject of cave art may have been influenced by the ideas of the art historian Max Raphael, as well as by those of Annette Laming-Emperaire with whom he worked closely at the Musée de l'Homme (see Max Raphael, *Prehistoric Cave Paintings*, New York: Pantheon, 1945; and Annette Laming-Emperaire, *La Signification de l'art rupestre paléolithique*, Paris: Picard, 1962).

explicitly to the manual creation of a material culture that is extracorporal. Gesture paralleled speech as a form of expression of mind and language. This notion of gesture is closely linked to a key theoretical and methodological concept, that of the *chaine opératoire*, or "operational sequence." Leroi-Gourhan makes it clear that apart from humans the behavior of many animals is characterized by such deeply embedded operational sequences. But only with humans do we see these operational sequences take material form and become more-or-less permanent constituents of the human environment.

For Leroi-Gourhan such operational sequences constitute the building blocks of technology, indeed of culture. They are culturally or ethnically conditioned and highly structured but through repetition and conditioning at a young age become more-or-less subconscious. Whether these operational sequences structure the fabrication of stone tools, the manufacture of personal ornaments, or the creation of painted and engraved underground sanctuaries, they are the focus of analysis. For archaeologists they represent an accessible entry to social organization and cosmology. But these operational sequences often remain unverbalized and unrecognized by those who practice them. That is why Leroi-Gourhan can claim to have recognized basic binary oppositions in the organization/structure of painted caves while explicitly stating that the meaning of specific images remains unknown and probably unknowable.

Because operational sequences are culturally/ethnically derived, they are the fundamental basis for what ethnologists, archaeologists, and art historians recognize as "style":

> The technical life of the hunter, and later of the farmer and the artisan, involves a large number of sequences that correspond to the many actions needed for their material survival. These sequences are empirical, borrowed from a collective tradition that one generation passes down to the next. Their principal trait, for all the unity of their broad outlines and their extension over vast polyethnic territories, is their strongly marked local and individual character. (*infra*: 253)

In American archaeology over the past twenty years, there has been significant concern with the concept of style which, while generally recognized as expressive of social identity, has been viewed in juxtaposition to function. Had these American scholars had access to this notion of operational sequences, this intellectual dead end might well have been avoided.

The focus on operational sequences in the analysis of human material culture of the past 2.5 million years serves, for Leroi-Gourhan, as an important guage of cognitive evolution. As he points out, the most complex operational sequences observable in the tools of the earliest members of our genus at the end of the Pliocene are no more complex than those observable among modern apes. Change in operational complexity over the succeeding 2.45 million years seems to occur at the painfully slow rate of biological evolution.

Shortly after 50,000 years ago something new and revolutionary occurred which Leroi-Gourhan terms "the origin of graphism." Not only does this change reveal that a cognitive threshold had been crossed, but graphism itself—what he conceives as a "language of forms"—had profound implications for the subsequent cultural evolution of humanity. It rendered possible the externalization of memory and hence mythological narrative. The complex but fundamental relationship between language and graphism is one of the more provocative recognitions of *Gesture and Speech*:

> Figurative behavior cannot be dissociated from language: It forms part of the same human aptitude, that of reflecting reality in verbal or gestural symbols or in material form as figures. Just as the emergence of language is connected with that of hand tools, figurative representation cannot be separated from the common source from which all making and all representation spring. Therefore we should not be surprised to discover a close parallelism in paleontological development and, in particular, to note a swift and profound change in materials at the moment *Homo sapiens* emerges from the last Palaeoanthropian stage. (*infra*: 363)

In 1964 there may have been those who scoffed at the future predicted in *Gesture and Speech*, specifically the continued trend toward the externalization of cultural memory. However, technological developments in computer technology over the past thirty years have exceeded even Leroi-Gourhan's predictions. As with his example of the invention of the printing press, computer technology began with a focus on words and numbers. But in the same way that images found their way onto the printed page in the eighteenth century, computer *image* technology now dominates much of the computer industry (as well as our lives), confirming, as Leroi-Gourhan explicitly observed, that language and graphism can never be mutually exclusive.

In most of Leroi-Gourhan's publications on prehistoric art, he appears to take more or less on faith that Paleolithic art (more frequently the terms "representation" and "graphism" are employed) and religion are fundamentally linked. Although one might be inclined to view this as received convention passed down from the Abbé Breuil, Leroi-Gourhan's predecessor as the dean of Paleolithic art studies, Leroi-Gourhan renders explicit in *Gesture and Speech* his theoretical reasons for linking the two phenomena:

> the reason why art is so closely connected with religion is that graphic expression restores to language the dimension of the inexpressible—the possibility of multiplying the dimensions of a fact in instantly accessible visual symbols. The basic link between art and religion is emotional, yet not in a vague sense. It has to do with mastering a mode of expression that restores humans to their true place in a cosmos whose center they occupy without trying to pierce it by an intellectual process . . .. (*infra*: 200)

He even notes provocatively (*infra*: 196) that modern advertising, like religion, "appeals to deep, infraverbal, states of mental behavior."

One of the more profound recognitions of this book is that the human species by virtue of expressive actions, both verbal and material, has been transcended by artificially and materially *constructed* ethnic or cultural entities that are in many ways the equivalent of biological species. For Leroi-Gourhan,

> The whole of our evolution has been oriented toward placing outside ourselves what in the rest of the animal world is achieved *inside* by species adaptation. The most striking material fact is certainly the "freeing" of tools, but the fundamental fact is really the freeing of the word and our unique ability to transfer our memory to a social organism outside ourselves. (*infra*: 235)

> The sociocultural divisions that make a particular technical operation typically New Caledonian in terms of both the method and the tools employed have simply taken the place of the psychozoological divisions that make certain operations and a certain physical apparatus typical of particular species of animals. (*infra*: 237)

Clearly, when Leroi-Gourhan speaks of a paleontology of language, of figurative behavior, and of material expression, it is a multivocal use of the term. On the one hand, his work on cranial equilibrium in vertebrates is literally paleontological, and is used to emphasize the critical importance of bipedalism for evolutionary changes that followed. When it comes to tools or visual representations, operational sequences are viewed metaphorically as the bones of the extinct societies or *ethnies,* which, as we saw above, suggest a human version of species defined, not by genetic barriers, but by barriers constructed of linguistic, material, and figurative expression.

Finally, it seems probable (if unverified) that certain so-called poststructuralist works such as Michel Foucault's *Archaeology of Knowledge* and Pierre Bourdieu's *Outline of a Theory of Practice* were influenced at least indirectly by Leroi-Gourhan's paleontological approach and emphasis on human action, respectively. We know for certain that Jacques Derrida in his *Grammatology* acknowledges an intellectual debt to Leroi-Gourhan.

Obviously a work that is thirty years old will have flaws and anachronisms. Moreover any work that claims to be scientific should be, to some considerable extent, empirically falsifiable. The reader should simply be aware of a few problem areas in this otherwise remarkable and historically important work.

First, in the years since 1964 there has been increasing awareness that a view of the evolution of graphism based in a single region such as Franco-Cantabria cannot be extended to the world at large. The inclusion of a wider sample of early representational evidence, much of which was known in the 1960s, casts doubt, for example, on Leroi-Gourhan's position that the earliest graphism took abstract or rhythmic forms. He paid no attention to the remarkable animal sculptures in ivory from south German sites that are as old as, or older than, the Châtelperronian objects from Arcy-sur-Cure.

Second, if in 1964 *Homo sapiens sapiens* was still viewed as emerging about 35,000 years ago (and probably in Europe and the Near East), this is no longer the case. Fossil remains of the oldest known anatomically modern humans are to be found in Africa and are dated to about 100,000 years ago. Nevertheless, there is virtually no evidence prior to 40,000 years ago for graphic representation. Thus there is an emerging scholarly consensus that the first graphic representation, personal ornaments, and so on, do not directly coincide with the biological emergence of *Homo sapiens sapiens*.

Third, the reader should be cautioned that *Le Geste et la parole* was written before the important discovery and recognition of *Homo habilis* in Africa, not to mention many other important discoveries such as that of the *Australopithecus* known as Lucy. Thus the overall taxonomic description is somewhat outdated, even obsolete.

Fourth, Leroi-Gourhan's chronology of the evolution of visual representation has been much criticized for being based on subjective evaluations of simplicity

(= oldest) and complexity (= most recent). With recent developments in the dating of both objects and paintings, it has become apparent that "crude" and "sophisticated" images existed contemporaneously.

Fifth, Leroi-Gourhan's attribution of signs as either male or female has been rejected by most scholars, including Leroi-Gourhan. By the end of his life he was ever more firm in the position that the meaning content of the signs themselves was probably unknowable, or at least remained to be demonstrated.[6]

As long as these limitations, resulting from a thirty-year gestation, are kept in mind, *Gesture and Speech* is an enduring, original, and profound exploration of human biological, cognitive, technological, social, and symbolic evolution.

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6. See, for example, A. Leroi-Gourhan, 1982, *The Dawn of European Art* (Cambridge: Cambridge University Press).

I Technics and Language

1 The Image of Ourselves

The search for human origins has been a basic concern for generations of human society from the earliest times. This desire to recover our aspect from the murky depths of the past has generally been satisfied at modest cost, and it remains so even today. Although peoples of modern culture are quite as anxious as their ancestors to discover whence they have come, for want of knowing whither they are going, a few brief allusions to the epoch of great apes will usually suffice to reassure most of them.

The need to discover our beginnings is so powerful that curiosity alone cannot be the motive. Many students of prehistory are very personally involved with their science; it is perhaps the discipline that has the most amateurs, one that some feel can be pursued without any special qualifications. When confronted with archaeological finds, almost all of us have a sense of returning to our past, and few, if given the opportunity, will resist the temptation to delve into the recesses of the earth like a child taking a toy to pieces. The quest for our mysterious origins, a quest with complex motivations, must surely have begun very early, for we know that toward the end of his long history, late Neanderthal man had already begun to gather fossils and oddly shaped stones. Although we can scarcely imagine Neanderthal man as having the same concerns as a prehistorian of today, no great effort is required to discern the same feelings, intact though still as vague, beneath the scientific shell of today's scholar.

To think oneself immune from the powerful need to return to the sources of humanity would be sheer vanity, but our analysis of those sources becomes possibly more lucid, and certainly more rewarding, if we seek to discover not only whence we have come but also where we stand today and perhaps whither we are going. The splendid upsurge of paleontology in recent years has produced an enormous amount of writing; there can scarcely be a reader to whom the Coelacanth's pawlike fin, say, remains a mystery. Among these there are less numerous works that have struck out in the opposite direction by trying to integrate our presence in our long prehistory. The interest aroused by writings about the slow ascent of humankind and of human intelligence shows to what an extent prehistory meets our deep need to confirm our place in space and time (see chapters 11 and 12). I believe that the only real significance of prehistory, whether resting on religious metaphysics or materialist dialectics, is that it situates the peoples of the future in their present as well as in their most distant past. Were this not so, prehistory would be, explicitly or implicitly, no more than the substitution of a scientific myth for the countless religious myths that dispose of the problem of our origins in a few words; or else it might be seen as a kind of epic poem narrating the prestigious adventures of heroes who were not humans. That is why, before embarking on a study of the geological relationship between techniques and language, it may be of some use to ask how the peoples at different times in history saw the human being that they were.

The Prescientific Period

We cannot tell how Cro-Magnon man imagined his own reality, but we have hundreds of myths borrowed from the most widely varying races, from the Eskimos to the Dogons. We have the great mythologies of the civilizations of the Mediterranean, Asia, and America, the works of the theologians and philosophers of antiquity and the Middle Ages, as well as those of preseventeenth-century European, Arab, and Chinese travelers. The image of humankind that emerges from them all is so coherent that a global analysis seems possible. At any rate it would help us to become aware of the changes that have taken place up to our own time in our perception of our own reality.

It is quite difficult for us today to conceive of a science of humankind which cannot draw upon geology, paleontology, or evolutionary theory but for which humans exist in an as yet unexplored universe and in a setting that is relatively timeless. In such a view variation means metamorphosis, emergence means spontaneous creation, and the concepts at which we now arrive by spreading existence over a time scale must be accepted as fantastic and determined by space alone. To the medieval mind *Pithecanthropus* would have come as no surprise; the medieval world would have accepted the ape-man as it accepted the dog-headed man, the unipede, and the unicorn. Early sixteenth-century maps, particularly of America, are still peopled by cynocephali walking like humans or by headless human bodies with eyes, nose, and mouth on their chests: an example is the map drawn in 1513 for the Turkish admiral Piri Reis, probably modeled on one belonging to Christopher Columbus.

The idea of change as a process was not positively formulable because all change was attributed to a god's or a hero's fiat. Philosophers could indeed glimpse the frontiers of fable within their own narrow experience—anthropological explorations have led them to define the human as the central being of the living world—but their vision was essentially ethnocentric. Ethnocentrism is in fact what best defines the prescientific vision of the human being. In many human groups "men" is the only word that the members use to designate their ethnic group. The identification of the ethnic group with a kind of ideal ego combining all the qualities of goodness and beauty has as its counterpart a tendency to believe that outside one's familiar world lies another inhabited by monstrous creatures whose appearance and habits represent the utmost in ugliness and evil. The same attitude is found in the prescientific period vis-à-vis the monkey, the civilized human's monstrous antithesis. This explains quite well the curious interchangeability of demons, unknown peoples, and monkeys in geographical imagery before the sixteenth century. The attitude we have described was to be directly transposed into eighteenth-century anthropology, where it gave rise, on the one hand, to attempts to provide a scientific justification for racial prejudice and, on the other hand, to human paleontology. Instead of considering all peoples to be identical in essence and placing them at the end of an evolutionary line, as we have learned to do, prescientific thinkers regarded as truly human only those who constituted their own ethnic nucleus, beyond which, in ever-widening circles, came beings of lesser humanity subject to more and more extravagant hybridizations.

The use of myths to resolve the problem of creation, lack of perception of the immense depth of time, ethnocentrism, and belief in a mystery world wherein the limits of the natural and the supernatural are lost within geographical confines characterize not only the Eskimo's and the Australian aborigine's but also the medieval explorer's image of humankind—an image variable beyond all biological reason in space but stable in a time without any depth. The popular sixteenth-century Chinese novel *Si Yeu Ki,* or *Voyage to the West,* by Wu Cheng-en, in which ethnocentrism and our interchangeability with our monstrous twin are superimposed on one another, clearly illustrates this view. The traveling priest San Ts'ang, accompanied by his disciples—the king of the monkeys, a boar with a man's body, and a fish in human shape—crosses the world in search of a mountain on top of which dwells the Buddha. In a series of long, stereotyped episodes the heroes travel through countries whose inhabitants are modeled on the Chinese but whose woods and hills are haunted by monsters, practically all of which are humanized animals. Ethnocentric superimposition of the Chinese world upon the human communities visited is combined with the monstrously dual nature of the imaginary inhabitants of unknown lands, while the travelers themselves assume dual form in the persons of a Chinese priest and three animals particularly rich in obscure symbolism—the monkey, the pig, and the fish.

Exploration of terrestrial space was to modify this image earlier than exploration of time. In the sixteenth century the monsters gradually began to disappear. The discovery of an ever-widening universe peopled by beings of different colors and customs, yet all undeniably human—savage or civilized, but designed on the same model—gradually introduced a rational image of humans. At the same moment in history the time scale too began to acquire a certain depth: The knowledge that American savages used stone weapons led to comparisons being made with our own prehistoric tools, and the idea of our material evolution, until then extremely vague, began to be rationally accepted. The sixteenth century with its "collections of curiosities" anticipated our own museums of natural history and ethnography. Most of the objects brought home at that time were weapons, items of clothing, or precious objects and did not differ fundamentally from the trophies of ancient times.

All works on prehistory make some mention, however cursorily, of the forerunners of that science. The Roman Lucretius with his five verses on the ages of stone and of metals[1] and Michele Mercati with his assertion, in the late sixteenth-century *Metalloteca,* of the human and very ancient origin of knapped stones, occupy an eminent place. But it must be emphasized that the paleontological problem as it appears to us was completely foreign to the minds of these precursors, whose view was basically the same as that of the primitives. By the time of the Renaissance the field had widened; ethnocentrism had changed its form and had begun to tend toward a hierarchization of human values which later was to lead to racism. Nevertheless, the new world still reflected the ancient separation. The barbarians had changed—the hyperborean monsters were becoming more and more questionable, but much of the basic image remained blurred.

The Seventeenth and Eighteenth Centuries

We now come to a point where the natural sciences are about to become exact. Comparative anatomy is beginning to develop and the problems that are the food and drink of the human sciences to this day are rapidly taking shape. The naturalist movement of the seventeenth and especially of the eighteenth centuries was comparable to the development of astronomy in the sixteenth: A vast area of universal organization is revealed in its marvelous architecture and immediately, for sociological reasons, begins to challenge the very foundations of religious philosophy. The encyclopedic passion of the late eighteenth century originated in the study of the natural sciences. Concern with the nature of humans of course is more than just an episode in the rationalist movement that was to sweep away traditional civilization. Yet it is interesting to note that within the general movement, the ideas were always ahead of the facts and that the consequences of our zoological origins had already been drawn more than a century before the discovery of the first human fossil.

On the basis of very sketchy evidence, the eighteenth century established a whole system of thought within which we are still operating today. In the thirty-six majestic volumes of his *Natural History,* written between 1749 and 1788 (the year of his death), Georges Buffon brings up within a mass of still shaky documentation the two problems that were to inflame nineteenth-century thought: Our zoological nature and the immense antiquity of geological eras. Buffon's personal contribution must be viewed as part of a broader scientific movement. The period teemed with works such as N. de Maillet's, published in 1755,[2] in which the author, proceeding on the strength of an astronomic, geological, and evolutionist theory somewhat short on documentary rigor, assigns the earth an age of several hundred thousand years. The battle of evolution was already joined on several fronts, although those fronts were not to intersect before the midnineteenth century, when geology, comparative anatomy, and ethnography converged with sociology. In 1735 the Swede Carl Linnaeus in his classification of living beings definitively established the zoological position of humans, who thenceforth became a species, *Homo sapiens,* the final stage in a series culminating in the primates. Paleontology at that stage was just barely implicit. Fifty more years had to pass before the logical order of living species found its counterpart in the chronological series of fossils, but from that moment onward, monkey and human were linked. The idea of a sequence of species came into existence, and although its logical consequence—the idea of our progressive emergence from among the primates—had not yet been clearly formulated, the image of the human being at the end of the eighteenth century was already strikingly close to that of our own.

The idea of zoological continuity was quickly accepted. In 1764 Louis Daubenton published a paper on "the position of the occipital foramen in humans and in animals," the first publication by far to deal with the question of erect posture. In 1775 the German zoologist Johann Friedrich Blumenbach propounded the anthropology of races in *De generis humani varietate nativa.* Finally, in 1789 the Englishman Gilbert White published a work on "the regular gradation of man and animals." Thus by the century's end the stage was fully set for the great casting-off of chains that was to follow. Humans were clearly seen in the variety of races and in their zoological proximity to the higher mammals. Only the restitution of depth to human time was still to come. Geology had already prepared the ground. Although the prescientific image of humans was a thing of the past, the dizzy descent into the depths of time had barely begun and paleontology was not yet born.

The Nineteenth Century

In 1800 the English naturalist John Frere published the results of an observation recorded in 1797 according to which chipped flint implements found in association with animal remains were to be attributed to the presence of humans in epochs far preceding the present. It was not until 1872 that John Evans drew attention to this observation, which at the time had gone unnoticed. To say that the nineteenth century merely reaped what the eighteenth had sown would be unjust. The works of Georges Cuvier, of Étienne Geoffroy Saint-Hilaire, and of Jean Baptiste Lamarck, as well as Jacques Boucher de Perthes' epic work and the abundant crop of anthropologists emerging everywhere in Europe, provided a *corpus* of science, each new discovery adding another element until a synthesis pivoted on Charles Darwin's evolutionism was finally reached at the end of the century. When Darwin's *The Origin of Species* was published in 1859, it bore little relation to the barely nascent science of prehistory. Rather, it marked the conclusion of the movement begun by Buffon. Like the eighteenth-century naturalists, Darwin—himself a naturalist, not a prehistorian or an anthropologist—grew from the subsoil of stratigraphic geology, paleontology, and contemporary zoology, for in the last analysis, whether seen as the consequence of evolution or as its culmination, humans can only be understood as part of a terrestrial totality. With Darwin, the encyclopedists' thirst was quenched once and for all, and although the edifice of evolutionism has been extended in depth there is no denying that since his time its essential content has developed but little. The conventional wisdom reflected this truth when it associated Darwin's name, mistakenly but revealingly, with the idea that "the human being is descended from the monkey." At the end of the nineteenth century, when prehistory as a hobby for amateurs was in its heyday, when the earth was yielding up the first skulls of Neanderthal man and *Pithecanthropus,* the image of the human was that of the simian ancestor slowly improved upon over the ages. As an image it ideally complemented that of the eighteenth century, when scholars had not yet dared to go beyond the view of the human as first cousin of the primates.

A dense fabric of differences has sprung up around this central idea of our zoological origin. Paleontology, anthropology, prehistory, and evolutionism in all its forms served to justify attitudes whose roots lay elsewhere. Because the problem of our origins is common to religion and to natural science—because by demonstrating the truth of the one, we have hoped to demolish the other—the "monkey" issue has tended to hold the center of the stage. Today it can hardly be doubted that the motivations involved lay outside the field of scientific inquiry. With the passage of time these wrangles have come to seem rather sterile. There is surely more profit to be derived from trying to find out how, through successive discoveries and hypotheses, the present image of humankind came to be formed.

The History of the "Prehuman"

Faced with facts for which any previous reference is lacking, our minds are helpless. It is true to say that human fossils were seen and interpreted with the eyes each period lent to its paleontologists. Since this is particularly striking in the case of the earliest finds, an attempt to review the main stages of interpretation in human paleontology may be of some value. Prehistorians before 1850 already had a considerable array of theoretical elements at their disposal. They knew that the earth was extremely ancient and that human life itself went back a very long time and had been marked by major geological upheavals. Proof of the existence of European man in the age of the reindeer and the elephant had already been produced, excavations in alluvial deposits and caves having begun toward 1810. The geological character of our past was already being taken for granted by some scholars in France, Belgium, and England. We can go still further and say that not even Lamarckian evolutionism and the certainty of our proximity to the monkey were recently acquired; indeed one of the finest Neanderthalian skulls had already been exhumed from the breccia of a cave at Gibraltar in 1848. As early as 1833, in the Engis cave in Belgium, Philippe-Charles Schmerling discovered the remains of a Neanderthal child, but this fossil became recognizable as such only after the discovery of a sufficient number of Neanderthalians and, in particular, of the child's skull of La Quina. The same was to some extent true of the Gibraltar man: If this fossil had consisted of a brainpan alone, it would probably have known greater success; the face, at a time when the myth of *Anthropopithecus* was being constructed, was incomprehensible. Jean Louis Quatrefages and Jules Hamy give an exact description of the fossil but attach no importance to it. Their concern with constructing the "race of Canstadt" on the basis of some highly questionable skull fragments closed their eyes to the real nature of Neanderthal man himself. But nothing was ready for establishing a connection between evolutionism and the available fossil records. The image of the primitive human does not appear to have been other than that of *Homo sapiens,* clad in the skins of animals he had hunted, applying his penetrating intelligence to fashioning in stone the weapons needed for his primitive economy. In the *Discourse on the Origin of Inequality* (1775), Jean-Jacques Rousseau was one of the first to outline a "cerebralist" theory of human evolution. By imitating animals and by reasoning, the "natural man," endowed with all the present human attributes but starting from scratch in terms of technical equipment, gradually invents everything within the technical and social order that will lead him to the present-day world. This picture, extraordinarily simplistic in its form, remarkably well employed to demonstrate the point that material progress is a blind alley, still survives, bereft of any trace of philosophical genius, in lowbrow works of popularization or prehistorical fiction of our day. In Rousseau's time the human mind was in no way ready to admit that the flints might have been knapped by a kind of semi-monkey.[3]

The next period falls between 1856, the date of the Neanderthal discovery, and 1880. The scientific atmosphere had changed completely. A chronological classification distinguishing the Paleolithic from the Neolithic eras was available to prehistorians. Within the Paleolithic, there was a Mammoth Age before the Reindeer Age. Above all, the myth of the ape-ancestor had taken shape, for the repercussions of Darwinian evolutionism upon scientific thought had been far stronger than those of Lamarck's theories. Besides, there were the fossils. The unfortunate Neanderthal man, broken into bits by workmen, owed to his natural resistance the preservation of a brainpan which proved to be the turning point in human paleontology. Exhumed in 1856, it was already recognized by H. Schaaffhausen in 1858 as evidence of the existence of primitive man. Ten years later, in 1866, Belgium supplied the mandible of La Naulette, which Quatrefages and Hamy introduced as part of their "race of Canstadt" in 1882.

Science was thenceforth in possession of the properties of the human ancestor, definable as a primitive being, stooping, flat-skulled, with prominent orbital crests and a receding chin. Linnaeus, Cuvier, and Darwin converge at last and the image of the ape-man comes into clear focus; he has a name, or even two, since in 1873 Gabriel de Mortillet was hesitating whether to call him *Anthropopithecus* or *Homosimian.*

An attempt to reconstruct the circumstances in which the remains of two authentic Neanderthalians engendered the legend of the ape-human is worth making. These remains included the only parts that could lend themselves directly to a comparison with monkeys: the orbits, the low cranial dome, the receding chin. Had Neanderthal man been exhumed intact, or had the Gibraltar skull not been found twenty years too soon, human paleontology might perhaps have resisted the powerful tug toward the monkey. But with the fossil records as they were, the interpretation was inevitable. The most serious and most persistent error was that of drawing a straight line linking *Homo sapiens,* via the Neanderthalians, with the impressive anthropoid foursome of modern times—the gorilla, the chimpanzee, the orangutan, and the gibbon. We shall return to this aspect of the problem further along.

Around 1880 humans were believed to be descended from the monkey via *Anthropopithecus,* of whom Neanderthal man provided what was thought to be a likely image. Scholars were not too sure where to situate the geological moment of our emergence; the most perceptive among them agreed that knapped or fire-crazed flints had existed at the very heart of the Cenozoic era, in the Miocene and Pliocene periods. If we consider that the discovery of *Zinjanthropus* in Tanganyika in 1959 established the presence of a toolmaking being not readily describable as human at the confines of the Cenozoic era, we realize that, here again, a great insight was founded upon false or nonexistent records; for the mistake lay in misinterpreting the characteristics of present-day monkeys, not in assuming the existence of very primitive human forms.

Not all scholars adopted the same attitude toward the matter. Paul Topinard in 1876 still found the image of a profoundly simian Neanderthal man difficult to accept and, taking up one of the ideas on atavism current at that time, vaguely suggested that the famous fossil might have belonged to a Mammoth Age survivor of the fabulous Cenozoic ancestors. Elsewhere every possible effort was made to find other representatives of the primitive race among already known fossils. In the *Crania ethnica* of 1873, Quatrefages and Hamy lumped the fossils of Neanderthal and La Naulette together with all sorts of fragments of present-day humans, such as the first mandible of Arcy-sur-Cure or the human remains of Canstadt, Egisheim, and Gourdan, to form an artificial "race of Canstadt" so flexible that very few fossil records, provided they were small and fragmentary enough, could not be fitted into it. This attitude is particularly interesting because the two great anthropologists lacked neither competence nor intellectual honesty: What they lacked were the basic elements for establishing a critical apparatus.

These subtle variations in the attitudes of different scholars are worth noting. G. de Mortillet with his *Anthropopithecus* (whose various races he goes so far as to name) pleads the cause of the ape-ancestor without producing any fossil as proof. He agrees to recognize a semi-monkey in Neanderthal man but is perturbed by his rather too human implements and invents an outlandish explanation based on atavism, according to which the skull itself belongs to a throwback to an earlier age (this attitude has reappeared periodically to this day). Hamy and Quatrefages literally dilute Neanderthal man by mixing him up in the "race of Canstadt" with the bric-à-brac of every human fragment they imagine to be a fossil. The hardly surprising result of this is that according to them Neanderthal man has kept reemerging atavistically down to the present day. The French anthropologists' tendency at this time seems to have been toward excessive generalization, whereas Thomas Huxley and W. King in Great Britain and Schaaffhausen in Germany, though they did not escape the general trend toward the simian theory, seem to have had a more correct idea of Neanderthal man's real place in the scheme of things.

The next twenty years brought little change. The Gibraltar skull slumbered on in the London collection where it had found refuge after being briefly recognized by George Busk in 1879; silence continued to reign on this subject. At Spy in Belgium in 1886, parts of a Neanderthal skull were at last found that allowed a practically complete reconstitution to be made but were not sufficient to identify its precise position on the vertebral column or to establish how prognathous it was. The major event of the period was the discovery of *Pithecanthropus,* the final avatar of G. de Mortillet's *Anthropopithecus,* by the Dutch scholar Eugène Dubois in Java in 1891. Truth to tell, this newcomer consisted yet again only of a brainpan, a few teeth, and a femur, but the demonstration was faultless: His forehead receded more than Neanderthal man's, his orbital ridges formed a veritable vizor, and so yet another link was added to the chain that bound the human to the chimpanzee. As for the femur, it was so perfectly human as to be almost embarrassing; a great deal of research was needed in order to detect a few discrete hints of an ability to climb. Our eyes see only what they are prepared to see, and the time had not yet come to understand what it is that radically separates the human lineage from that of the anthropoids. Already the possibility of reconstituting *Pithecanthropus*' appearance was envisaged, and indeed a life-sized plaster portrait was shown at the universal exhibition of 1900 (figure 3). Although full of errors in points of detail, this reconstitution actually offers a silhouette of our human ancestor that differs little, roughly speaking, from that accepted today: The forehead is very low, the chin recedes strongly, the general look is wild—but, for all that, the posture is almost erect. What is unlikely is the position of the skull upon the neck, the shape of the hand, the length of the arm, and the weird compromise between a human foot and that of an orangutan so that our ancestor seems to be standing on something very much like two lobster claws. A few hairs on the chest, a fig leaf, two nondescript implements made from deer antlers, and a line in the middle of a flat forehead complete the portrait of the missing link at the threshold of the twentieth century. For a long time yet paleontology remained caught in the compromise between *Homo sapiens* and the anthropoid ape, and to this very day not only does the image of the ape-human reign supreme in popular literature, but a kind of nostalgia for the primate ancestor can be detected in certain highly scientific works.

The Twentieth Century

The first years of the twentieth century were marked by the greatest series of finds of the primitive human ever made. At an extraordinarily rapid rate, the earth yielded up the Mauer jawbone and the skeletons of La Chapelle-aux-Saints, Le Moustier, La Ferrassie, La Quina, and Krapina. Human paleontology became a science, and prehistory, in its turn, advanced considerably. A fairly detailed chronological framework from the Acheulian to the Magdalenian was now available. Climatic variations were better known, and the geologists' chronology asserted an order of magnitude of thousands of years even for the more recent period, a claim that was to be proved acceptable by later developments. Anatomical anthropology, vigorously advanced from the midnineteenth century by Paul Broca and his successors, reached its zenith, and the controversies that accompanied the sharing out of the fossils among the world's experts were, with some exceptions, more courteous than those of the preceding generation. The image of *Pithecanthropus* progressed no further. The australopithecine revolution of the 1940s and 1950s had to take place before the way to a solution of the problem of the missing link was open at last. Neanderthal man, on the other hand, took on an almost familiar look; Neanderthalians were being found all over the place, sometimes in a fairly good state of preservation, young men and old, women and children, and various European laboratories vied with one another in the skill of fitting together the minute fragments of which the finest samples were, alas, made up. In 1911–1913 Marcellin Boule published a fundamental work on the man of La Chapelle-aux-Saints which encompassed the problem of Neanderthal man as a whole. Looking back from the vantage point of today on the work of the great human paleontologists at the beginning of the century, we cannot but be struck by the scientific rigor of their analyses and the pertinence with which they defined, in relation both to ourselves and to monkeys, the ancient forms of humanity known to them. The monkeys, it is true, troubled the serenity of their studies. If we glance at the pictures with which these works are illustrated, if we reread the morphological analyses they contain, we realize what tricks monkeys have played with scholars over the ages. Rooted as it was in the unchallengeable eighteenth-century idea of our closeness to the great primates, human paleontology was quite incapable of envisaging any solution other than one that lay between the monkeys it knew and *Homo sapiens*. To look at the fossils objectively became almost impossible. Indeed one might almost say that to look at them at all became pointless, for to a certain extent they could only hamper the search for the perfect midway solution. This explains why the phenomenon of 1870, when Hamy produced his description of the Arcy-sur-Cure jawbone considered a priori as belonging to Neanderthal man, continued to occur each time it came to describing *Pithecanthropus* or Neanderthal man: Scholars could see in what respects he differed from ourselves and resembled a monkey, but much more time had to elapse before it dawned on them that the supposedly simian characteristics might be no more than the reflection of a common origin so remote that the comparison became meaningless. The period of extremely rigorous anatomical description we are speaking of was tinged with something like regret that the evidence failed to bear out the midway solution. This is particularly clear in the matter of the foot, which *ought* to have a slightly more prehensile big toe (or rather, thumb); the femur, which *ought* to be incurved; the arm, which *ought* to hang down a little more, the thumb, which *ought* to be short, the spine, which *ought* to bend forward, and, above all, the occipital foramen, which ought to occupy a position halfway between the gorilla's and our own.

All too often the reconstitutions of the time tended to bestialize the Palaeoanthropians: The idea of "inevitable prognathism" won through because that was the way skull fragments were reassembled or drawings or photographs rearranged. The paleontologists are hardly to be blamed. With the theories current at the time, the faces of the incomplete fossils discovered later (Broken Hill, Steinheim, Saccopastore, Monte Circeo) were quite simply unimaginable. The convenient shelving of the Gibraltar skull with its normal face-to-cranium ratio clearly shows the irresistible tendency of fossils to follow the image they are invited to illustrate. The only fossil in which the relationship between the skull and the face was intact was also the only one that refused to fit into the pattern of "normal" evolution.

To be fair, we ought not to overlook the fact that even today there exist only a few fossils of which the skull was not found broken, incomplete, or deformed. Some degree of interpretation is therefore unavoidable. The reconstitutions of *Sin-*

anthropus or *Pithecanthropus* were mosaics made up of fragments taken from different individuals; facts as fundamental as the position of the head upon the vertebral column or the length or prognathism of the face were still a matter for hypothesis. Human paleontology succeeded in exorcising the ape-ancestor only very recently, when by dint of finding older and older fossils in a better and better state of preservation it was obliged at last to bow to the evidence. Admittedly our venerable ancestor had a small brain and a large face, but he walked upright and the proportions of his limbs were those that we know of humans. Between 1900 and 1920 that recognition still lay far ahead and the Neanderthalian image was to be given sculptural form, no longer in plasterlike Dubois' *Pithecanthropus* but in fine stone, looming like a colossus on the esplanade in front of the museum at Les Eyzies to celebrate the sum of erroneous traditions of a century and a half of scientific struggle.

After 1920

From 1920 onward the theater of the primitive human shifts once more to the pithecanthropine stage. Through the combined efforts of Davidson Black, Wen-Chung Pei, Pierre Teilhard de Chardin, Abbé Henri Breuil, and Franz Weidenreich, the discoveries of Peking man in the cave of Choukoutien were to give fresh impetus to our knowledge about the earliest humans. Doctrinal positions had changed considerably since the end of the nineteenth century, and human paleontology now shared its favors between defenders of the faith and champions of atheistic evolutionism. The wrangles that had done so much to promote, but also to deviate, research in the eighteenth and nineteenth centuries were dying down amid general indifference, although their traces were to live on into the present time in certain ideas accepted in the heat of battle and never since revised. What seems to have struck scholars most forcibly toward 1930, when a considerable body of documentation on the Peking Sinanthropians began to be available, was the almost startling contrast between these cousins of *Pithecanthropus,* who corresponded perfectly to the ideal ape-human, and the presence among their vestiges of hearth ash and of a stone industry which, it had to be admitted, was really quite highly developed. Some accepted this fact, others took up an attitude that was to resurface on other occasions and that might be described as the theory of the "hunter of Sinanthropians" or of "*Homo presapiens.*" This attitude, which was widely held in the years 1930 to 1950, consists in suggesting that the bones are indeed those of a being halfway between human and ape but the industry and the fire connote the presence of a much more highly developed being for whom the unfortunate *Sinanthropus* was merely a prey.

We shall revert to the deep causes of this attitude, already held by Jacques Boucher de Perthes, in other early chapters of this volume. The same phenomenon recurred when, upon discovering the *Australopithecinae* in 1924 and thereafter, some scholars looked for their possible hunters, when some thought that the man of Broken Hill might have been killed in a recent period, and when for some time there were hesitations in conceding to the African cousins of *Pithecanthropus*—the Atlanthropians of Ternifine discovered in 1954 an industry of knapped flint implements as fine as those that accompanied their remains in the deposit.

Even quite recently an Italian prehistorian, P. Leonardi, came forward with the suggestion of a "true hominid living in the same epoch [as *Zinjanthropus*] . . . and remaining unknown."

Less formally the *Anthropopithecus* hypothesis was being replaced by that of an elusive hominid with a human intelligence, arriving no one knew whence in a world where various prehominids still lingered. This particular aberration of what was already a modern science was unfortunately encouraged by the scientific hoax which kept Piltdown man within the field of hypothesis for almost fifty years. Everyone knows that in 1909 an English forger arranged for the learned world's discovery and acceptance, together with a few Acheulian flints, of disparate pieces of a modern man's skull and an equally recent chimpanzee's jawbone. Painful because of the loss of time it entailed and because of the regrettable lines it caused certain scholars to write, the Piltdown hoax provides the clearest confirmation of everything we have said in the preceding pages on the subject of the ape-ancestor myth. The finest experts recognized without hesitation that the touched-up fragments of the composite Piltdown creature were fragments of a human skull and a chimpanzee's jawbone. Some of them left it at that, but the majority, prudent caveats notwithstanding, were prepared to accept the hypothesis that an ape's jawbone could be attached to a human skull, so what Cuvier would have regarded as anatomical heresy served for a long time to underpin the "*Homo presapiens*" hypothesis. Once again, the point at issue was neither incompetence nor lack of good faith. Such a view of the ancestor reflects the thinking of an entire epoch, from which the paleontologist is not exempt. The word "presapiens" came at its appointed hour, when the ape-ancestor had not yet been completely eliminated (chimpanzee's jawbone), when increasingly thorough knowledge of ancient industries allowed a human intelligence to our precursors dating back as far as the Acheulian (human skull), when the presence of extremely primitive fossils (Pithecanthropians) showed that at the back of the late Cenozoic stage had lived beings to whom it was almost indecent to ascribe an industry as developed as theirs. The only way out pointed toward an ancestor whose condition was still close to the simian but who, under the convexity of his skull, might already have possessed a brain that ensured him the best of futures in the modern world. The Piltdown *Eoanthropus* even had the honor of being bracketed together with two fossils of more solid status, the skulls of Swanscombe and of Fontéchavade. It is difficult at this point to know what to think, not of the authenticity of those fossils but of their real characteristics, for both are fragmentary to such a degree and lack such essential parts that it might be best to wait before saying anything at all for fear of suffering the same misadventure as Hamy, who associated the jawbone of La Naulette with human remains subsequently found to be far more recent. The case of the Piltdown man could demonstrate the possibility and the danger of taking the opposite course.

To sum up, one might say that in 1950 the image of the primitive human was undergoing a far-reaching transformation. As in all times of change the various positions were not always very clear-cut, and the finest scholars were sometimes torn between contradictory hypotheses. The old trend continued to persist, and the reconstitutions of Sinanthropians or of the new series of Pithecanthropians found in Java from 1934 on were inspired by the old ape-ancestor idea. However, some Neanderthalians had been discovered in good enough condition for the base of the skull not to have to be assembled in a laboratory. As far back as in 1921 it had been established that the man of Broken Hill could not have had the ape-ancestor's half-bowed posture because his occipital foramen indicated complete erectness. At the time this characteristic had caused much perplexity. In the end the fossil had simply been rejuvenated by some who considered it (as Topinard had done with Neanderthal man in 1875) to be a sort of throwback of a prehuman skull on a man's body. Some had gone so far as to draw attention to the striking contrast with the half-bowed posture of the Neanderthalians, a posture that in fact had only been the product of the evolutionist idea in the minds of those who had reconstituted the remains.

The caveats entered concerning this fossil whose skull testified to erect posture are highly significant. W. P. Pycraft tried to demonstrate that the pelvis corresponded to half-bowed posture. Other authors, faced with the unambiguously human character of the pelvis and femurs, tried to argue that they did not belong to the same skeleton as the skull. Marcellin Boule (and H. V. Vallois, who went along with him on this issue) adopted a slightly different position by suggesting that Rhodesian man might have lingered on in the present-day world and ended up by walking upright like *Homo sapiens*. Not until Giuseppe Sergi was able to study fossils with an intact skull base following the discovery of the Saccopastore skull in Italy in 1939 did the central idea that prehumans already walked upright begin gradually to be accepted. The same discovery in relation to the *Australopithecinae* of South Africa was to suffice at long last for the image of the ape-human to undergo substantial change.

Today

At the time of writing, research on humans is dominated by the *Australopithecus* clan, which first made a discrete appearance upon the scene when Raymond A. Dart discovered a child's skull at Taung in South Africa. Since then finds have multiplied on the African continent until the discovery in Kenya in 1959 of the remains of the Zinjanthrope, a large Australopithecinian accompanied by his stone implements. These discoveries have had a profound effect upon the manner of considering the problem of human origin. They create an image that would have been completely disconcerting to the encyclopedists: Gabriel de Mortillet's *Anthropopithecus* is now known, but he has nothing in common with the original model. He is, with all the anatomical consequences that this implies, a man with a very small brain, not a superanthropoid with a large brainpan. In chapter 3 it will be seen to what extent this finding necessitates a revision of the concept of the human being; for when Louis Leakey with his Zinjanthrope confirmed that a being built basically like ourselves, walking upright and knapping flints, existed in the Villafranchian period, he contributed far more than Dubois did with his *Pithecanthropus:* He provided the means of overcoming a line of thought that had persisted without weakening throughout the nineteenth and the first half of the twentieth century.

The Criteria of Humanity

A little more than a century after the discovery of the Gibraltar skull, what picture can we form that will meet all criteria common to all humans and their ancestors? The first and most important criterion is erect posture: As we have seen, it was also the last to be accepted. This meant that for several generations the problem of human origin was posed upon a false premise. All known fossils, including the oddest among them such as *Australopithecus,* show humans to have had erect posture. Two further criteria are corollaries of the first: They are a short face and a free hand during locomotion. Not until the last few years, bringing as they did the discovery of the pelvis and femurs of *Australopithecus,* did it become possible to understand the connection between erect posture and a short face. The search for this connection forms the subject of the third chapter of this volume. Facial proportions are reflected in the characteristics of the teeth, and it is this which may one day make it possible to pick up the traces of *Australopithecus'* ancestors. A few years ago the newspapers were full of the *Oreopithecus* of Monte Bamboli in Tuscany, going so far as to dub him "the man aged two million years." This fossil's dental characteristics suggest a shorter face than a monkey's.

Freedom of the hand almost necessarily implies a technical activity different from that of apes, and a hand that is free during locomotion, together with a short face and the absence of fangs, commands the use of artificial organs, that is, of implements. Erect posture, short face, free hand during locomotion, and possession of movable implements—those are truly the fundamental criteria of humanity. The list includes none of the characteristics peculiar to monkeys and makes the midway form of human, so dear to pre-1950 theoreticians, completely unthinkable.

The fact that my list does not include a large brain may be thought surprising. Of course it is difficult to assign preeminence to any particular characteristic, since in the development of species everything is interlinked, but I believe that there can be no doubt that to some extent cerebral development is a secondary criterion. Once humanity has been achieved, the brain plays a decisive role in the development of human societies. In terms of strict evolution it is undoubtedly a correlative of erect posture and not, as was thought for a long time, primordial.

The situation of the human, in the broadest sense, thus appears to be conditioned by erect posture. The phenomenon would seem incomprehensible were it not one of the solutions to a biological problem as old as the vertebrates themselves, that of the relationship between the face as bearer of the organs of nourishment and the forelimb as an organ not only of locomotion but also of prehension. Backbone, face, and hand (even in the form of a fin) were indissolubly linked from the very beginning. This astounding paleontological adventure forms the subject of chapter 2.

The situation created by erect human posture certainly represents a stage along the road that leads from the fish to *Homo sapiens,* but it in no way implies that the monkey was a staging post along that road. It is conceivable that monkeys and humans had a common source, but as soon as erect posture was established there was no more monkey in humans and, consequently, no half-human. The conditions created by erect human posture had consequences in terms of neuropsychological development; this meant that the development of the human brain was something other than just an increase in volume. In the development of the brain the relationship between face and hand remained as close as ever: Tools for the hand, language for the face, are twin poles of the same apparatus. This is discussed in chapter 3.

Homo sapiens represents the last known stage of hominid evolution and also the first in which the constraints of zoological evolution had been overcome and left immeasurably far behind. The new conditions for development offered to tools and language form the framework of chapters 4 through 6, which complete the first part of this work.

The second part is devoted to the development of the body social, which forms the prolongation of the anatomical body. In *Homo sapiens* divisions into species and races have been submerged by divisions into ethnic groups, whose physiology is founded upon the group's collective memory. The gradual substitution of social memory for the biological instinctual apparatus is discussed in chapter 7, its effects upon the evolution of technics in chapter 8, and its consequences for the evolution of language transmission in chapter 9.

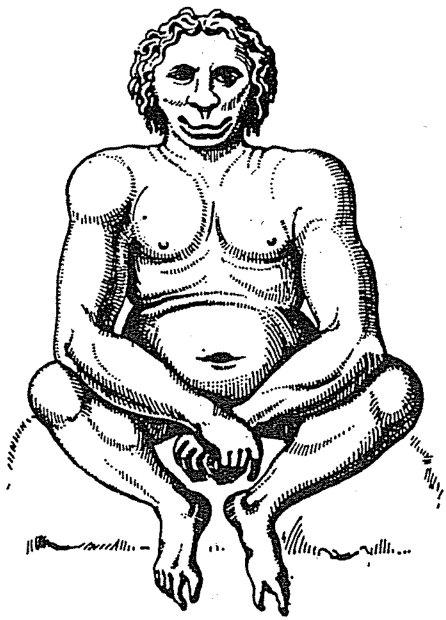
The third part, which deals with values and rhythms, is an essay in aesthetic paleontology and ethnology. In it I have attempted to gather together the elements necessary for a study of certain facts that normally escape systematic investigation. The sets of values that give every human group a personality of its own at each moment of its history are discussed in chapter 10. A classification of forms of aesthetic expression must necessarily be arbitrary, since it is in the very nature of art to touch upon many spheres at once. Nevertheless, it seems possible to distinguish between certain progressively more organized stages. Accordingly chapters 11 and 12 are devoted in turn to physiological aesthetics (much of this forming part of animal behavior) and to functional aesthetics, which relate principally to manual action in technical activities. Chapter 12 tackles the subject of the humanization of social behavior, one of the problems that, together with that of instinct, have sustained the comparative study of animal and human societies. The subject is considered in turn from the point of view of humanization of time and space and from that of the symbolic organization of the body social. Lastly, art—a human activity whose paleontology is supported by extensive evidence—forms the subject of chapter 14.

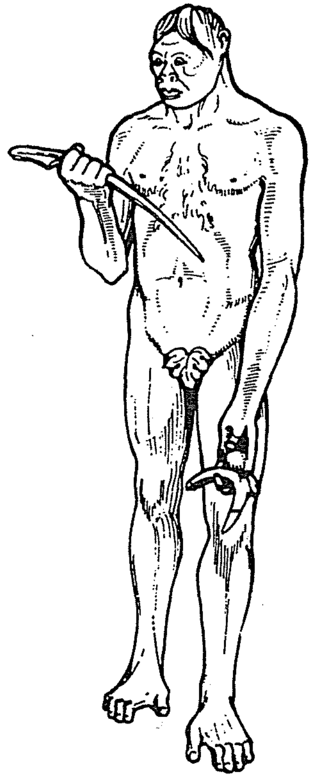
The final chapter is taken up, by way of conclusion, with the consideration of the human adventure. Its two principal themes are the balance, unique in the living world, achieved between the individual and the body social which is the individual's indefinitely perfectible extension in action, and the future considered as the extension of the paleontological trajectory.

It may be felt that a work that calls to witness all the main spheres of the human sciences must lack harmony. While writing it, I have been only too aware of its weaknesses and imperfections, and its vulnerability on that score has certainly not escaped me. But how, without invoking paleontology and language, technics and art, was one to show that our uniquely organized mammalian body is enclosed and extended by a social body whose properties are such that zoology no longer plays any part in its material development?

A place should perhaps have been set aside for psychoanalysis. The myth of the ape-ancestor has roots in the twilight of time (figure 1). Its emergence in the eighteenth century coincided with the moment when the fantastic cohort of clawed and hairy monsters, of wild men with wolves' heads or fishes' bodies, was just beginning to withdraw from the scene. Column capitals and bestiaries, comic strips, and fairground monsters suggest an image of the human that belongs to depth psychology; when all is said and done, it is an image not altogether foreign to that proposed by the paleontologists. The anthropoid (figure 2) came next, soon to be followed by the rather imprecise image of *Anthropopithecus* standing on the threshold of his cave (figures 3 and 5). It is a scholarly myth that in our day still gives satisfaction to the educated but also has its popular counterpart in the abominable snowman (figure 4) and in the Tarzan of the comic strip and the neighborhood picture house—Tarzan, the ideal primitive man, handsome like the ancestor dreamed up by Boucher de Perthes but freed from the connotations of an apelike nature by the presence of his friend the chimpanzee . . .

1. Fourteenth-century stained-glass window in the church of Saint Ouen at Rouen. Demon leaving the body of a woman possessed. Note the demon's "humanized monkey" look: the jutting eyebrows, wide nostrils and snoutlike nose, clawed hands, and simian big toe. An elongated object is held in his left hand.





2. Orangutan of Borneo, according to Beckmann, 1718. Note the humanoid appearance. The low forehead, wide nose, muzzle-shaped lips, and opposable big toe are stereotypical characteristics of the ape-human.

3. Pithecanthropus *as reconstructed by Dubois for the Paris Exhibition of 1900. The jutting orbits, wide nose, lips forming a muzzle, excessively long arms, opposable big toe, and ill-defined objects held in the hands indicate that the image of the ape-ancestor had evolved but little in the space of six centuries.*

4. The abominable snowman, from Radar, *1954. Except for the length of the arms, which incidentally is inconsistent with erect posture, the resemblance to the fourteenth-century window is striking.*

5. The man of Les Eyzies, who dominates the sanctum of human paleontology and continues to furnish massive evidence of all the mistakes made by that science and of our thousand-year-old ape-ancestor complex.

2 Brain and Hand

So it was thanks to the manner in which our bodies are organized that our mind, like a musician, struck the note of language within us and we became capable of speech. This privilege would surely never have been ours if our lips had been required to perform the onerous and difficult task of procuring nourishment for our bodies. But our hands took over that task, releasing our mouths for the service of speech.

—Gregory of Nyssa, *Treatise on the Creation of Man,* A.D. 379

There is little we can add to this quotation except perhaps by commenting in the language of the twentieth century upon what was already evident sixteen hundred years ago. Though it arrives at the same conclusion by a different path from Gregory of Nyssa's, paleontology too speaks in terms of "release," of liberation. Within a perspective which starts with fish in the Paleozoic era and ends with the human in the Quaternary period, it is as though we were witnessing a series of successive liberations: that of the whole body from the liquid element, that of the head from the ground, that of the hand from the requirements of locomotion, and finally that of the brain from the facial mask. That this impression is an artificial one is obvious, for by concentrating on a few selected fossils we create a very incomplete picture of evolution. But if there is one truth against which no convincing demonstration has ever been produced, it is that the world grows more mature with each succeeding age and that our choice of pertinent forms illuminates a long, steadily ascending path upon which each "liberation" took place at an increasingly accelerated rate.

The pertinent forms in this sequence are those that, at each stage of the process, achieve the most perfect balance—from the triple point of view of nutrition, locomotion, and the organs of responsiveness—between mobility and capacity for survival, fundamental characteristics of species selected to demonstrate the progression of the living world. The biological advantages of changelessness can be demonstrated just as readily, the geological longevity of the jellyfish or the oyster offering positive support, but the point of evolutionism is not so much to sing the praises of slow-motion development as to relate the living world, explicitly or otherwise, to the modern human. Leaving aside any attempt to find a philosophical meaning in evolution, leaving aside even the assumption implicit in "transformism," it is thus normal and scientifically sound to observe to what a striking degree the urge to conquer time and space, our dominant trait, is also characteristic of all the witnesses selected to illustrate the ascent of the human being.

It is possible to regard mobility as the significant feature of evolution toward the human state. Paleontologists have not been unaware of this. It came more spontaneously to them to characterize humans by their intelligence than by their mobility, and the first concern of their theories has been with the preeminence of the brain. This has often falsified their interpretation of fossils, especially from the primates onward. The conquest of air-breathing, the release from crawling, and the achievement of bipedalism are topics that have been studied thoroughly for the past half-century; nevertheless, it is worth noting that barely ten years ago the idea of a quadruped possessed of a human brain would have been accepted almost more readily than that of a biped as cerebrally backward as *Australopithecus*. The "cerebral" view of evolution now appears mistaken, and there would seem to be sufficient documentation to demonstrate that the brain was not the cause of developments in locomotory adaptation but their beneficiary. This is why locomotion will be considered here as the determining factor of biological evolution, just as in part III it will be seen as the determining factor of modern social evolution.

The Dynamic Organization of Animals

Animals differ from plants in that their nourishment involves the intake of food in units that must be mechanically processed before any assimilative chemical process takes place. In other words, nutrition in animals is to a considerably greater degree than in plants connected with the search for food and therefore involves the use of mobile capturing organs and of a detection mechanism.

Despite its generally mobile character the animal world has from the outset included a significant number of species that, without adopting the purely chemical nutritional processes of plants, have adapted themselves to capturing food while remaining immobile. There are thus two types of dynamic organization of animal species, one in which the body is constructed on a radially symmetrical pattern and one in which the symmetry of the body is bilateral.

Among the invertebrates, the sponges and the coelenterates (hydras, sea anemones, polyps) offer perfect examples of an organization in which the part played by locomotion is nil and in which the system is organized on a radial pattern. However, in certain other orders—worms, molluscs, echinoderms, or crustaceans—the sedentary habit of the adults is a secondary phenomenon, and the adoption of that way of life suggests that their evolutionary path is completely different from that of mobile species. For the purposes of our argument, these forms, which have developed into what is considered to be the lower animal world, are of interest only by way of comparison. They do, however, demonstrate at the lowest level of the living world what in a finalistic view would be described as a choice between two possibilities. This apparent choice is constant and justifies the expression "branching development" used by paleontologists to describe the diversification of living beings.

Bilateral organization, on the other hand, is directly relevant to our argument since, by a series of successive consequences, it is this form of organization that has led to the human being.

Bilateral Symmetry

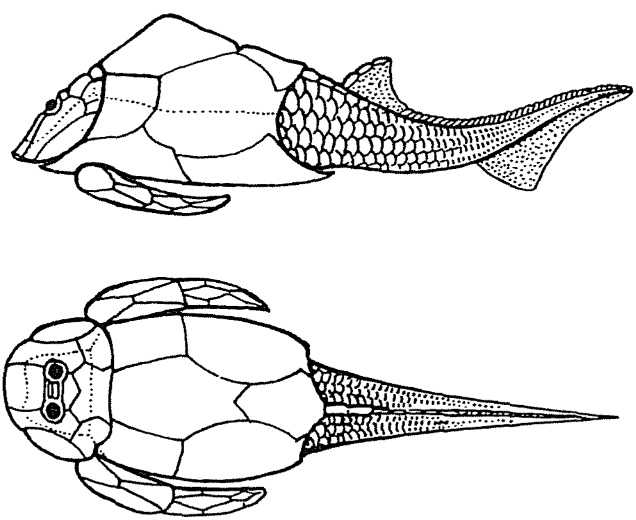
The design whereby the entire organism is placed behind the aperture for ingesting food is to be found in the most mobile of the protozoans, and except in sponges and coelenterates, it is the normal design of animal bodies. The anterior polarity of the mouth and of the organs of prehension of mobile animals is so obvious a biological and mechanical fact that to dwell upon it would be ridiculous, except perhaps in order to stress that it is this fact and no other that represents the fundamental precondition for evolution toward higher life forms.

Mobility implies that for purposes of nourishment the organs that ensure orientation, adjustment of position, and the coordination of the organs of food capture with those of food preparation must also be situated in front of the body. From the first acquisition of mobility to the present time, the general structure of an animal—whether insect, fish, or mammal—has not changed. The polarization of certain organs has thus led to the formation of the *anterior field* within which the complex operations of animals with bilateral symmetry take place.

The Vertebrates

Having turned our back upon the radially constructed animals and selected those whose symmetrical organization is determined by the axis of movement, we must now take leave of the invertebrates as a whole and consider the development of animals with an internal skeleton.

The first appearance of vertebrates—ostracoderm fish (figure 6), still lacking a jaw, which illustrate vertebrate organization in its oldest and most schematic form—dates back to the middle of the Paleozoic era (Silurian and Devonian periods). Already, as in the fish of today, their body is divided into two parts, the anterior forming a solid bony box and the posterior part articulated by wide scales and ending in a tail. The locomotory part is built round a fibrous longitudinal axis, the notochord, along which runs the spinal cord from which are derived nerves that control the contractions of groups of muscles arranged in bilateral series to form the animal's sides and protected by the flexible armor of the scales. The locomotory appa-



6. Ostracoderm fish of the Scottish Devonian, from Traquair.

ratus, here at its very simplest, is constituted by two bands of muscles whose alternate contractions activate the propulsive tail.

The head is a flat box formed of imbricated plates, pierced with orifices, within which all the elements of the anterior field—organs of prehension, ingestion, and responsiveness and the whole nervous apparatus that operates them—are combined. There are no jaws; the mouth is an opening shaped like a sucker, whose periphery is equipped with electric organs. The functions of prehension and food ingestion are thus performed by very different means than in later vertebrates, and the mechanical role of the cranium is still limited. But the brain box already houses the fragile nervous apparatus that controls the organs sensitive to light, vibrations, taste, and smell, grouped at the extremity of the spinal cord. This node of specialized nerve cells is already the center of operations from which fibers not only spread out to the sense organs but also control and coordinate the system as a whole.

Between the brain box and the body, at the boundary between the anterior field and the part concerned with locomotion, is a pectoral fin or articulated paddle. All the elements necessary for the analysis of vertebrates as far as the human being are already there: a rigid cranial box framing the mouth and protecting the brain, locomotory organs closely connected with the base of the skull, and the anterior limb located somewhere between the two.

The ostracodermi offer a picture of a vertebrate that borders on the schematic, both because they lived at a time close to the vertebrates' earliest beginnings and because they belonged to the category of organisms whose evolution at any moment proceeds in directions other than the one that interests us. Like the lampreys or hagfish of today, to which they are related, the ostracodermi, fish with suckers, have a structure that has never been subjected to certain selective factors. The situation is altogether different with the elasmobranchs (sharks and rays), bony fish, and dipnoans (and coelacanths), which, as far back as in the Devonian period, were already jawed vertebrates and showed a great variety of combinations.

With the help of embryology as much as of fossils, paleontologists have established that the mandible of vertebrates must derive from one of the arches that support the gills. The exact process which, from the Devonian onward, culminated in the emergence of fish with an articulated jaw has not been completely elucidated, but it is certain that from that time on the skull of vertebrates acquired a new and most important function, that of serving as a support for the jaws. After that, the mechanical constraints of locomotion and those of operating the jaws were to dominate cranial development as a whole.

As early as in the Devonian period, when jawless fish were in their heyday, these three orders—elasmobranchs, bony fish, and dipnoans—represented an obvious point of departure toward higher forms. Certain types already were modern fish, both phylogenetically and functionally, and the ancestors of the coelacanths and the modern lungfishes already show features that foreshadow adaptation to life on land.

The foregoing pages, which merely summarize a set of long-established facts to be found in any work on human evolution, are included in the present work only because they demonstrate an important point. The whole animal kingdom was divided from its earliest beginnings into a relatively limited number of functional types, the choice (not always completely clear-cut) being between sessile and mobile habits or between radial and bilateral symmetry. From the point of view of "biological success," both tracks have led to equally striking results: Jellyfish have survived without variation for several hundreds of millions of years, while the mobile animals, through the vertebrates, have provided the stages needed to attain intelligence. The winners in this endless race, the jellyfish and the human, stand at the two extremes of adaptation. Between them lie the millions of species that constitute the "tree" of terrestrial genealogy. These lines of functional evolution have become a commonplace: Who does not know the example of the shark, the ichthyosaurus, and the porpoise (a fish, a reptile, and a mammal) which, by adaptation to the aquatic medium, came to have the same external form? The facts of mechanical adaptation are normal; for example, in dental organization there are many cases where animals as disparate as the hare, the horse, and the ox have molars of similar mechanical structure. If this phenomenon, described as "convergence," were adopted as the basis for a taxonomy, the result would be very different from the phyletic "tree," but many of the branches would be common to both.

This functional convergence can operate for an entire order, even among mammals, as with the marsupials of Australia, which include false carnivores, false ruminants, and false rodents. It can operate for isolated forms and result in extraordinary resemblances. I need only cite the example of the Proterotheriidae of the South American Miocene, which followed the same specialization line of specialization as the Equidae and produced lineages of false hipparions and false horses with a surprising functional resemblance to real ones.

Biology ascribes change in species, at least in summary, to the combined effects of heredity and natural selection. In addition the cumulative effect of adaptations to the environment leads in time to an increasingly efficient organization of the nervous system. The move from the aquatic to the terrestrial environment and the emergence, toward the end of the Mesozoic era, of homoiothermy that offered considerably greater possibilities of adaptation to birds and mammals than to cold-blooded animals, renewed the register to which functional adaptation could be applied. The nervous system was the most obvious beneficiary of this evolution, to which it gives an extraorganic dimension, since it leads eventually to the human brain. This end result, which was possible for one lineage only, would be inconceivable unless we assumed the existence of favorable conditions, fairly generalized at first, and then, nearer to the present time, increasingly restricted. Thus the point of departure was from a very broad and very deep biological base, and only by ignoring the millions of species that took but little advantage of successive sets of favorable conditions can we speak of our lineage. The first and most important of those conditions, as we have just seen, was the constitution of the anterior field, a development that affected most animal species and all vertebrates.

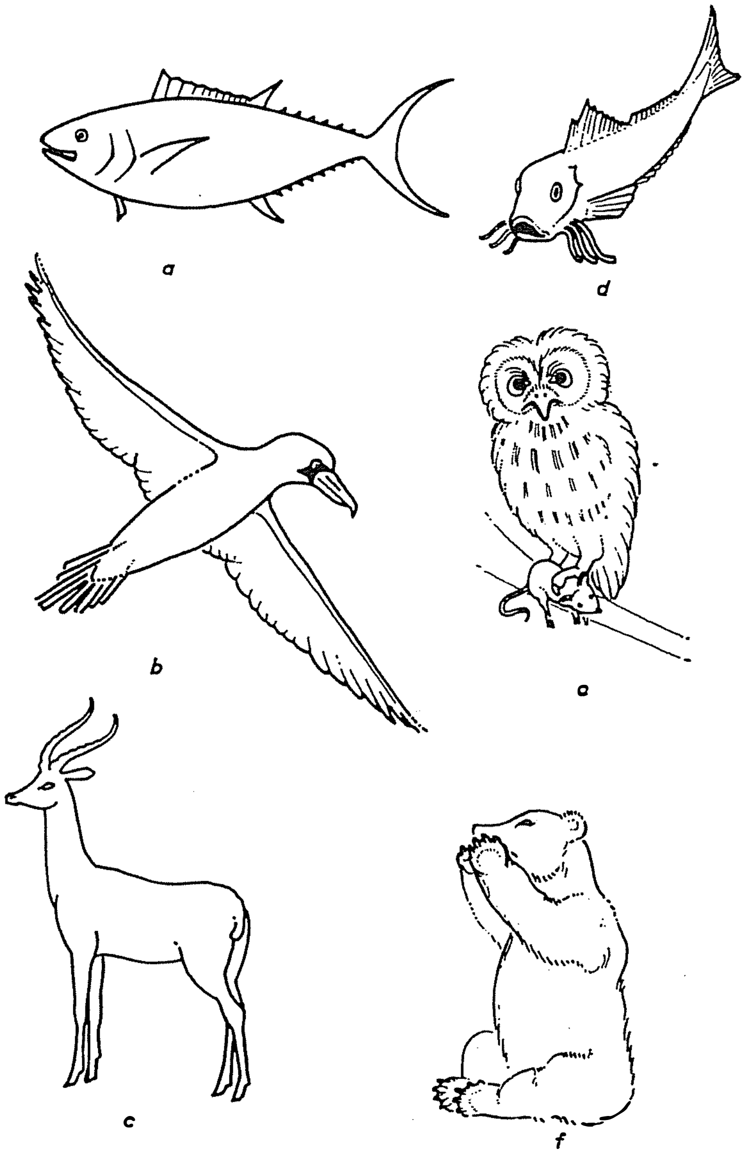
The Evolution of the Anterior Field

The second favorable condition, which is evident in a large number of animal species, is the division of the anterior field of responsiveness into two complementary areas, one governed by actions of the head and the other by those of the forelimb or, more precisely, by actions of the facial organs and of the extremity of the forelimb, respectively. The anterior field thus has a facial pole and a manual pole, which act in close relationship to perform the most elaborate technical operations.

The position of the forelimb between the cephalic and locomotory parts of the body is functionally somewhat ambiguous. In both the Arthropoda and the vertebrates, the anterior organ of locomotion can, to varying degrees, serve for the capture and preparation of food. The fact is particularly clear in decapod crustaceans such as the crab, where the first pair of legs, developed into claws, serves to grip and break up the prey. Examples of a bipolar anterior field are fairly common among the arthropods. But in the vertebrates they are very numerous indeed, and their significance is particularly great.

Independently from any taxonomic division into classes and orders, the vertebrate world can be divided into two functional groups, that in which the forelimb is used almost exclusively for locomotion and that in which it intervenes more or less actively in the anterior field of responsiveness (figure 7).

Such a division is already foreshadowed in fish. In the majority of surface or deep-water species, the pectoral fins are associated solely with locomotion, acting as organs of orientation or slow movement. In species that live near the bottom, on



7. *Examples of two types of anterior fields.* Left column: *Almost exclusively facial.* (a) *Fast-swimming fish (tuna),* (b) *long-flying bird (Bassan gannet),* (c) *walking mammal (gazelle).* Right column: *Facial and manual combined.* (d) *Deep-sea fish (gurnard),* (e) *bird of prey (brown owl),* (f) *grasping omnivore (bear).*

the other hand, the pectorals are often directly associated with the search for food, either by acting like fans to stir up mud and uncover gobbets of food, as with the tench, or by turning into "legs" or barbels rich in taste buds that explore the bed while supporting the fish as though on crutches, as with the gurnard. In amphibians and reptiles the forelimb plays a very limited role, although in some species it helps to hold the food down on the ground or to clear the mouth of unwanted or ill-tasting fragments.

In birds the situation is given a special twist by the adaptation of the forelimb to flight. The Opisthocomus or hoatzin of tropical America is the only modern example of a bird with a "hand" used for climbing—and even here, this peculiar feature is confined to the young of the species. Thus in birds there is no question of the forelimb intervening in the anterior field of responsiveness, although in many species the back limb is used to grip the prey or, as with the weaver bird, to perform certain nest-building operations. The case of birds is of interest because it proves that the possibility of intervention by the "hand" not only exists in a limited number of zoological groups on the direct line of evolution from the crossopterygian fish via monkeys to humans but is even to some extent independent from any specific anatomical area. In the case of the bird's foot, as in that of the elephant's trunk, it is more a matter of functional reality than of zoological predisposition.

The situation of mammals is directly connected with the subject matter of this book and needs to be discussed in greater detail. There appear to be two broad groups of more or less homogeneous composition, the first including primates, insectivores, edentates and bats, rodents, cetaceans, and carnivores, and the second comprising the very large assemblage of ungulates, which includes all hoofed mammals from the elephant to the horse, pig, and ox.

A similar separation can be made from a functional point of view: The first group includes species with a varied diet (carnivores, frugivores, or omnivores) and oriented essentially toward "fleshy" food, whether animal or vegetable; the great majority of ungulates, on the other hand, are eaters of foods rich in cellulose.

If we attempt a separation between species in which the forelimb plays a role in the anterior field of responsiveness and those in which that role is slight or nonexistent, we are again left with two main groups: on the one hand, the first of the groups described above (with the exception of the cetaceans), where cases of such involvement are numerous, and, on the other hand, the ungulates and cetaceans, where there are no cases of such a kind. And finally, from the viewpoint that concerns us most, bipolarity of the anterior field, though widely distributed, is confined to only eleven of the twenty-six orders constituting the whole category of placental mammals. In each of the eleven orders that show bipolarity, a new distinction has to be drawn according to what are sometimes considerable differences of degree. As will be seen further on, while it is among these mammals that coordination of the facial and manual fields is most highly developed, such coordination is far from being present—or present to the same degree—in every group: Neither edentates nor bats offer noteworthy examples, except for fish-eating bats and frugivorous flying foxes whose back limbs can, as in birds, be used for gripping food. In the insectivores, a very archaic group, the extent of the hand's intervention is very variable. It may be practically nil, as in the tenrec of Madagascar, very slight, as in the mole, or again very considerable, as in the tree shrews, whose taxonomic inclusion among insectivores or primates is still under discussion. Carnivores too show different degrees of manual intervention, although in practically all species the hand intervenes in the anterior field of responsiveness to some extent. In the Canidae and Hyaenidae the involvement is slight because of the great importance of the adaptation of the limb extremities to rapid movement over long distances; in the Mustelidae, the Viverridae, the Procyonidae, the Ursidae, and the Felidae, on the other hand, the participation of the hand can reach a degree fairly close to that observed in primates. The raccoon's manual abilities, for example, are so great that in some tests it can compete with certain monkeys.

Within the order of the Rodents, the functional apparatus varies considerably. It is here that we find the most striking contrasts in the sense with which we are particularly concerned. Certain forms within the suborder of the Hystricomorpha, such as the capybara of tropical America or the guinea pig, show only traces of manual intervention, while the Sciuromorpha (squirrels or rats) include many species where, as in some carnivores, the role of the hand is almost as important as in certain monkeys. It should be noted that in carnivores, insectivores, and rodents alike, the species with the most pronounced manual intervention are also those whose forelimb often exercises a gripping action during locomotion, whether it be on the ground or in trees.

The characteristic just described is still more striking in the primates, all known forms of which show a highly developed connection between the forelimb and the anterior field of responsiveness. This connection is, however, a matter of degree, the action of the colobus monkey's hand not being the same, from either the anatomical or the neuropsychological point of view, as the gorilla's. It will be seen further on that the world of monkeys is as varied as that of rodents and that this variety offers some insight into the mechanism whereby the human has become the only living species in which a far-reaching connection between the facial and manual poles is achieved without the forelimb intervening in locomotion. Before we turn to the effects of the fundamental connection between head and forelimb, we must briefly consider the case of the ungulates which, having struck out in a different direction from ourselves and having developed much further than ourselves in their locomotory adaptation, never showed any association of the hand with the facial organs. The passage that follows, taken yet again from Gregory of Nyssa's *Treatise on the Creation of Man,* might have been written about them:

> Yet it is above all for the sake of speech that nature has added hands to our body. If man had been deprived of hands, his facial parts, like those of the quadrupeds, would have been fashioned to enable him to feed himself: His face would have been elongated in shape, narrow in the region of the nostrils, with lips protuberant, horny, hard, and thick for the purpose of plucking grass; the tongue between his teeth would be very different from what it is, fleshy, resistant, and rough, so as to crush his food together with the teeth; it would be moist, capable of allowing food to flow down its sides, like those of dogs or other flesh-eating animals, which allow food to flow through the interstices between their teeth. If our body had no hands, how could the articulated voice form inside it? The parts around the mouth would not be so constituted as to meet the requirements of speech. In such a case man would have had to bleat, bark, neigh, low like the oxen, or cry like the ass, or roar as the wild animals do.

This is exactly what contemporary paleontology and zoology demonstrate in the case of the ungulates: Absence of the hand's intervention is in fact compensated by an extremely varied facial specialization. Not only are very complex forms found in the dental organization of, say, the horse or the elephant, but also other facial organs show considerable structural diversity, which to some extent makes up for the forelimb's deficiency. The greatest development is observed in organs concerned with grasping or defense that directly replace the hand or the canines. Suffice it to mention the extensible lips of the manatee, the trunk of many living or fossil species from the tapir to the elephant, the horns on the snout of which the rhinoceros is the last possessor in the modern world, the canines transformed into tusks or the horns or antlers of ruminants.

Gregory of Nyssa's explanation cannot of course be taken literally. The remarkable thing about it is that at the end of the fourth century A.D. a philosopher should have sensed so distinctly the relationship between speech and hand. We should note too that he does not see this relationship as the commonplace one whereby the hand participates in speech through gesticulation but as an organic one, manual expertise corresponding to the degree of freedom of operation of the facial organs thus made available for speech.

The conclusion that can be drawn from the foregoing is that while a paleontology based solely upon anatomical and chronological observations is valuable in that it establishes the broad lines of evolution, there is also value to be found in a different approach to biological facts that also takes account of behavior. In fact the two approaches are mutually complementary; that is what I have tried to demonstrate thus far. Research in the direction we are pursuing here results in a history of functional mechanisms whose very widespread occurrence in the living world can alone explain, against a background of more and more relevant adaptive variations, the emergence of a human form still deeply rooted in the animal world and obviously similar to those mammals that at a later stage adopted the most highly developed forms of integration of the two poles of the anterior field.

From Fish to Human

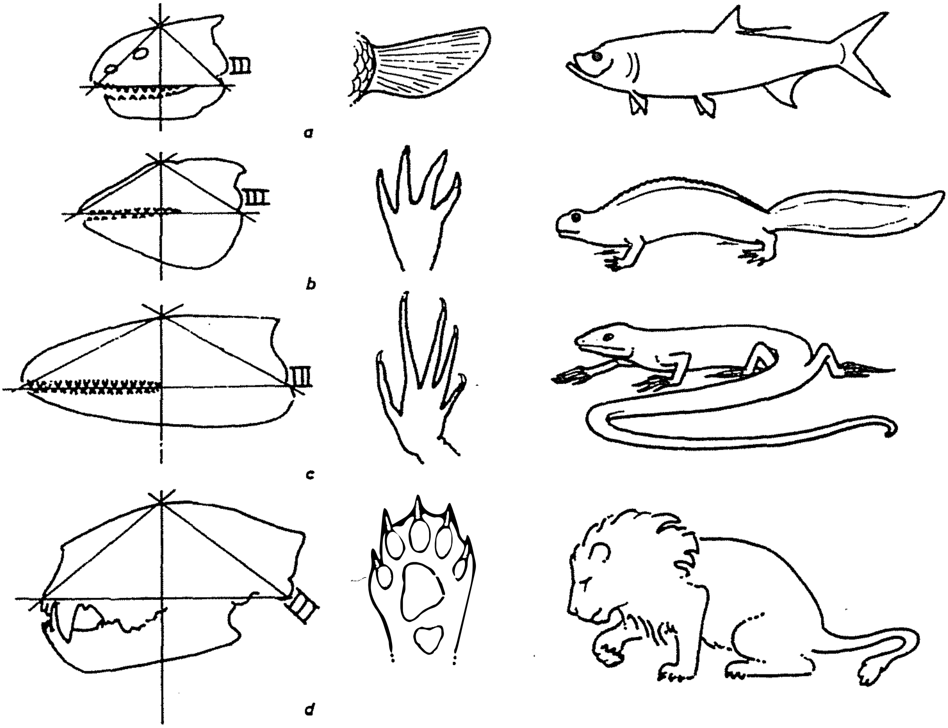
Having acknowledged the leading role played in the development of vertebrates by variations in the balance between the two poles of the anterior field, we can proceed to a more detailed study of the forms taken by those animals that achieved the highest levels of technical integration in the course of the whole history of living organisms. In other words, against the background of the vast documentation assembled by study of the paleontology and biology of vertebrates we can attempt to sketch out a functional paleontology. To do this, we must include within a single perspective the main functional elements of each of the types that succeeded one another over the ages. For purposes of convenience the number of these elements may be reduced to five. The first pertains to the constraints of locomotion—to *the mechanical organization of the vertebral column and the limbs.* This element is indissociable from those that follow because the organs of motion are the driving gear of the way of life. The second element is the *suspension of the skull.* Because of the skull's topographical location, this is the most sensitive element of the functional apparatus; this fact has been empirically understood since the very beginnings of paleontology, Daubenton's celebrated study on the position of the occipital foramen in vertebrates having inaugurated a long series of works around the central theme of the suspension of the skull. The next element is *dentition,* whose connection with the way of life can be readily understood if we take into account the role played by the teeth in defense and in capturing and preparing food. The fourth element is the *hand,* or at any rate the extremity of the forelimb, and its possible integration with the technical field. Lastly, the fifth element is the *brain,* whose role as coordinator is obviously a primordial one but which functionally appears as the "tenant" of the rest of the body. This situation of the brain, which could be described as subordinate to the edifice as a whole, has been noted and recorded many times without its significance being wholly clarified. It is common knowledge that the skulls of functional types that closely resemble one another—such as the theriodont reptiles of the early Mesozoic era, the carnivores of the early Cenozoic, and the carnivores of the Quaternary periods—have housed increasingly developed brains, the earliest being scarcely larger than the spinal cord. This simple fact may suffice for the present to establish that there is no special relationship between the evolution of the brain and that of the body which that brain controls. Yet, as we have shown in chapter 1, it was the contrary idea that dominated our image of the primitive human for a century.

Isolated study of each of the elements that forms part of the composition of vertebrates can afford only a very incomplete understanding of functional evolution. Their integration, on the other hand, reestablishes a zoological order in a number of major categories that characterize functional states. Following both chronological order and the systematic order of the natural sciences, we shall examine successively (figure 8) and in relation to the characteristics we have selected the major stages of ichthyomorphism, amphibiomorphism, sauromorphism, theromorphism, pithecomorphism, and anthropomorphism[4] which correspond, respectively, to the stable way of life in an aquatic medium, the first liberation from that medium, the freeing of the head, the acquisition of erect quadrupedal locomotion, the acquisition of the seated posture, and finally that of erect posture.[5]

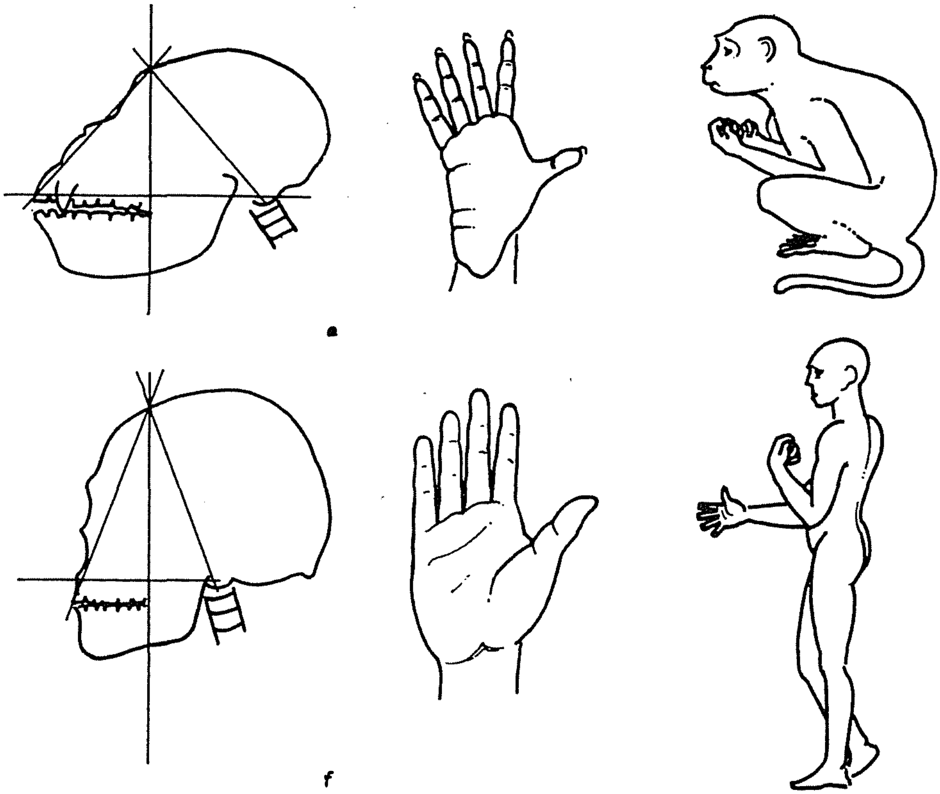
Ichthyomorphism

The dynamic organization of fish has not varied since the emergence of the first jawed fish in the Devonian period. The fish achieves locomotion essentially by lateral strokes determined by the action of opposing muscles supported by the vertebral axis. This apparatus propels the cephalic extremity, with which it is closely integrated, and is completed by fins which, as far back as in the middle of the Paleozoic era, already corresponded in number and position to those of fish existing today.

The frame of the cephalic extremity is a bony case that has the triple role of supporting the teeth, providing a base for the insertion of the mandibular muscles,



8. Different functional types. Left column: *Cranial structure related to posture and dentition.* Middle column: *Hand.* Right column: *Grasping posture.* (a) Ichthyomorph—*suspension in an aquatic medium, no cervical mobility, long homodont tooth row;* (b) amphibomorph—*crawling on the belly, lateral mobility of the head, long homodont tooth row;* (c) sauromorph—*crawling partially off the ground, free neck, tooth row in the front half of the skull;* (d) grasping theromorph—*occasionally free hand, heterodont tooth row;* (e) pithecomorph—*hand free when seated, opposable thumb, back part of the skull freed by the vertebral column;* (f) anthropomorph—*hands completely free, erect posture, mechanical disengagement of the convexity of the skull.*



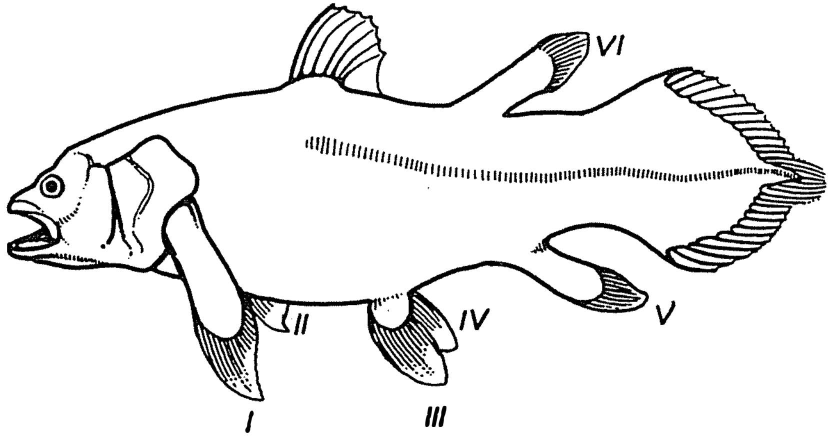
and protecting the organs of responsiveness. To this cranial box are attached the mandible, the hyoidian bones that support the gills, and the bones of the pectoral girdle that carries the skeleton of the forelimb. The cephalic bloc is rigidly integrated with the body by groups of muscles; the vertebral axis acts not as a support but simply conducts the extremity of the spinal cord into the skull where it forms a minute brain suspended within the vault. All the elements to be borrowed in the evolution of land vertebrates are already there, but they will have to undergo a complete mechanical overhaul in order to adapt to life on land.

Aerial Respiration and Land Locomotion

The transition to life on land is generally presented as a simple and unique phenomenon affecting certain fish that became amphibian and thus came to form the slender root of the hugely branched genealogical tree of land vertebrates. In reality zoologists are familiar with numerous fish belonging to a variety of groups that by dint of some mechanism or other, manage to assimilate atmospheric oxygen directly. Quite a few zoologists even regard the swim bladder as a retrogressed lung. At any rate the existence of a functional relationship between those two organs is an established fact. Aerial respiration is necessary to species living in shallow and poorly oxygenated waters, and the link between the acquisition of means to escape asphyxia and of locomotion in search of water on muddy ground is fairly obvious. Like bilateral symmetry or the choice between prehension and exclusive locomotion, aerial respiration and land locomotion represent a choice, this time between adaptation exclusively to the aquatic medium and adaptation to life on land. To this choice, many species have responded in different ways, one of which is that of the amphibious quadruped.

There have been other solutions, several of them surviving until the present time, for example, the eel which can absorb oxygen through its skin, the Indian climbing perch (Anabas) with its modified bronchial chambers, and the lungfish whose swim bladder is a true lung. The number of true fish that offer examples of partial adaptation to aerial respiration is so great that respiration, rather than the locomotion peculiar to quadrupeds, may safely be considered the decisive factor.

Land locomotion itself is accomplished in different ways. It may be simple crawling, as with the eel, and the movements involved may not be different from those of swimming. It may take the form of displacement using one side of the body. All fish resort to this form of movement spontaneously when taken out of the water. But in some species, such as the climbing perch, it may involve covering a considerable distance in the same direction. The case of the crossopterygians, and more especially of the coelacanth, seems to me to represent a real adaptation to displacement using the sides of the body (figure 9). In these species the fin is supported by a lobe that resembles a short nonarticulated limb. Besides the two pectoral and two ventral fins (which correspond to the limbs of quadrupeds), there are three further lobed fins, one on each side of the tail and one at its extremity so that the animal when lying on either of its sides has five points of support for purposes of locomotion. The coelacanth, near the base of most genealogical trees of higher animal forms, in reality only illustrates an exceptional system of locomotion, and its limbs bear only the inevitable minimum of relation to those of the quadrupeds' possible ancestors. For all the intrinsic interest of the extraordinary survivor that is the *Latimeria,* it would be unwise to see the starting point of human genealogy in a group of fish that resolved the problem of land locomotion in a manner completely different from that of quadrupeds.



9. The latimeria, *a coelacanth found in 1938. The fins are mounted on short limbs like those of early quadrupeds (I to IV), but segments V and VI suggests a recumbent mode of locomotion unrelated to the further evolution of quadrupeds.*

It is among the crossopterygians with their cylindrical bodies that we should seek the origin of amphibians, insofar as we can hope to find a particular ancestor for so general a feature as choosing to live on land. The second part of the Paleozoic era—the Devonian, Carboniferous, and Permian periods—saw the emergence of the land vertebrate. The problem of monophyletism may in fact be a false one, for whatever explanation we choose, only one trend, that toward life on land, is perceptible. The response really does not seem to have been unique. Numerous partial solutions still exist today, such as those of the climbing perch (Anabas), the mudskipper (Periophthalmus), the Australian lungfish (Ceradotus), the newts, the frogs, and the toads. These give a picture of possible transitions from true fish to reptile, but the picture is multidimensional and made up of phyletically disparate elements.

Amphibiomorphism

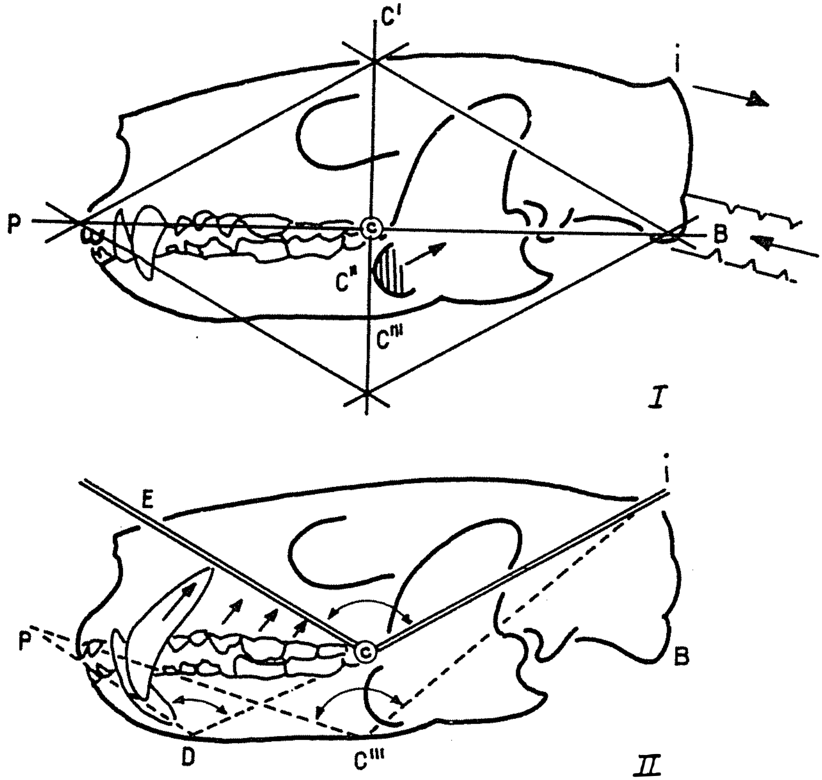
The amphibian solution is still only a halfway house—one might almost call it provisional. The vertebrates that have adopted it remain tied to the aquatic medium because of their damp skin and their reproductive mechanism, and cannot stay away from it for long. However, we find that in the earliest amphibians the major mechanical problems have already been resolved more than just in outline. The land vertebrates are already set upon a definitive path.

The first amphibians whose body structure we can reconstitute go back to the Carboniferous period. Their general appearance is reminiscent of that of our newts or salamanders. The caudal axis serves as a motor in swimming, and four meager limbs assist locomotion on the ground. The pectoral girdle still connects with the skull so that the mobility of the head is practically nil, but the elements of the skeleton of all later vertebrates are already present: The pelvis is so constituted as to allow walking, the bones of the arms and legs are the same as ours, and the hands and feet have five digits.

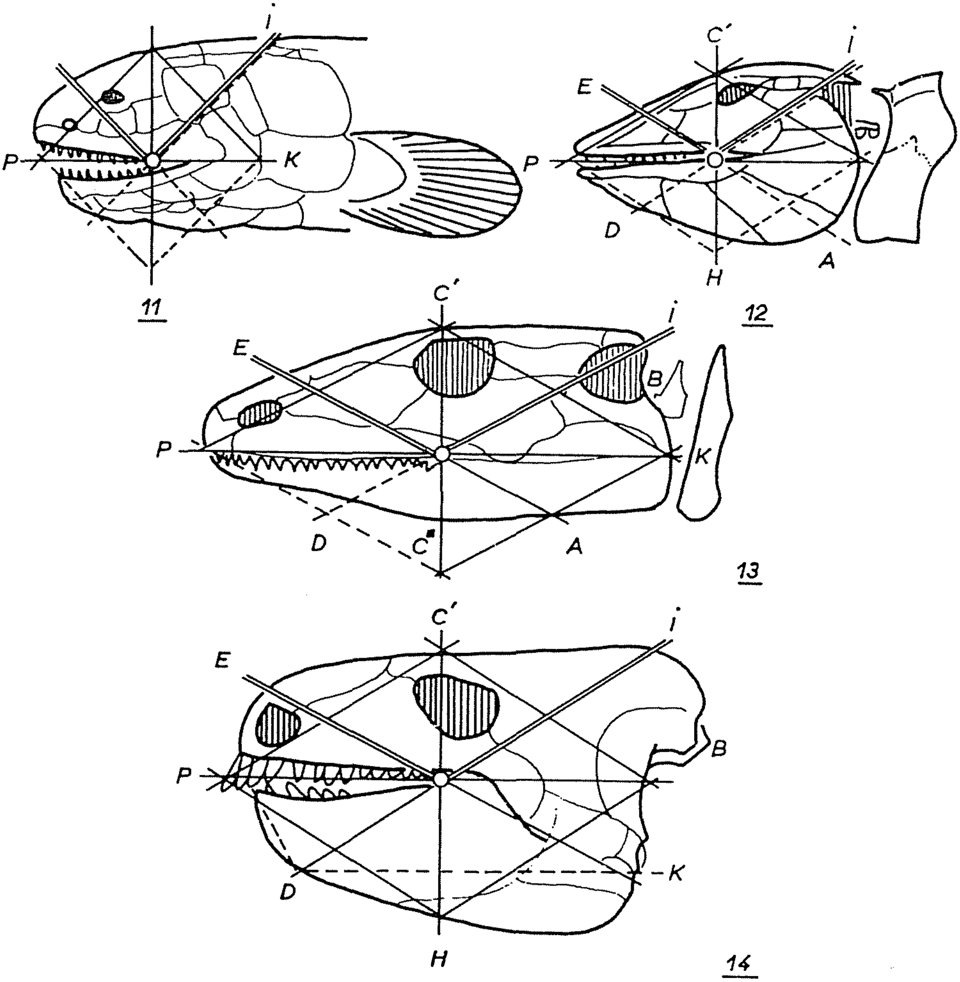
The cranial structure is particularly interesting. The transition from water to land involves new mechanical stresses because the head is no longer supported in a dense medium; instead, it is cantilevered at the end of the body. In fish, suspension in an aquatic medium means the absence of vertical flexional stresses on the head. The mechanical factors that intervene in the design of the skull are limited to the action of the mandible (tractional stress of the masticatory muscles) and to the existence of an upper maxillary support system that absorbs mandibular stresses. Upon transition to terrestrial life, the effect of suspension of the head, exercised upon the back of the skull, is added to this mechanical traction and support mechanism. Mechanical balance is achieved by way of an increasingly economical integration of the three types of stresses (figure 10).

Weight is now exerted upon a lever that runs from the tip of the muzzle (*prosthion*) to the point at which the skull articulates with the backbone (*basion*). The skull is kept horizontal by the set of muscles and ligaments that pull on the upper part of the nape of the neck (external *inion*), following an inion-basion lever arm that counterbalances the effect of weight. The reconciliation of mandibular and suspensional stresses is a thread that runs through the entire cranial evolution of all vertebrates, including humans. Dentition and posture are closely linked from the outset. Paleontologists were quick to realize that vertical posture and a short face were the essential characteristics of the human being, but the functional link that explains these two characteristics has not as yet been clearly identified. That is why I consider it essential to go back to the origins of the vertebrates.

The amphibian skull supplies only a sketchy outline of a solution, but it is a highly significant one. The earliest amphibian cranium is still very close to that of a fish (figures 11 and 12). Nevertheless, the shoulder is already detached and the iniac suspension has become effective. Crawling on the ground imposes a curious constraint in that the mandible has not sufficient room for grasping; in species where the limbs do not yet raise the head from the ground the upper jaw is raised together



10. Mechanical construction of a vertebrate's skull. I: The skull is divided by a quadrilateral figure into a facial and cerebral half along the line C'–C'''. The center is situated behind the last of the teeth halfway along the line P–B (prosthion-basion). The vertebral column is articulated upon the basion and provides the main support for the skull. The cervical ligament is inserted in the external inion I and provides a means of flexible suspension. The temporal and masseter muscles are hooked to the ascending part of the mandible, with C'' as the front boundary. II: The line E–C forms the base for the absorption of pressures on the teeth, the roots of the upper canines barely touching this line. The "pair of compasses" in the center (E–C–i) represents the mechanical stresses that determine the development of the skull. In the case shown (a carnivore of the early Cenozoic era), the entire convexity of the skull is mechanically locked. The symphisian (P–D–i) and jugal (P–C'''–i) "compasses" represent the stresses imposed by the lower tooth row. They play an important role in the constitution of the lines of resistance of the base of the skull and the base i–B. In the case shown, all the angles equal 120 degrees. Equiangularity is an archaic trait; in more highly evolved forms the opposing angles correspond to one another.



11–14. Stages from swimming to quadrupedal off-the-ground locomotion in fish, amphibians, and reptiles during the Paleozoic era. Figure 11: Fish (Rhizodopsis) of the Carboniferous period. The structure is square; there are no suspension points. Mechanical stresses are confined to mandibular pressures. Figure 12: Amphibian (Eogyrinus) of the Carboniferous period. The head is still connected with the scapular ossature and has very limited mobility, but the structure is more elongated. Figure 13: Reptile (Seymouria) of the Permian period. Cervical mobility is more pronounced (i–B base still very short). The mandibular height is reduced; the tooth row does not extend farther back than the center. This functional type is close to that of the present-day crocodile. Figure 14: Theromorph reptile (Jonkeria) of the Permian period. Locomotion on limbs raised from the ground has been acquired, and the skull has undergone many changes. The base I–B has lengthened to form the lever arm required for suspension from the top of the vertebral column. The teeth are still of identical shape but show differences in size that represent the first stage of heterodonty.

with the entire calvarium,[6] like the lid of a box. This transitional solution involves iniac traction and promotes the head's mobility upon the trunk.

Hold your chin steady, open your mouth, and feel the muscles at the nape of your neck come into play. Now you can imagine the mechanical state of the first amphibians and the role it might have played, together with the evolution of the forelimbs, in separating the shoulder and forming the neck. Indeed this structure was soon to be left behind: Before the end of the Paleozoic era, the saurian solution, with its much simpler mechanical balance, had already replaced it among the amphibians themselves.

Sauromorphism

If we look for forms that illustrate steps in the evolution of mobility and an increasingly rich and complex existence, the next stage is that of the "lizard," still tied down to the ground by crawling but completely freed from the respiratory problems of amphibians (figure 13). The saurian solution already existed in the Permian period before the beginning of the Mesozoic era more than two hundred million years ago. The sauromorphs were the first vertebrates completely to resolve the problems of mechanical balance in a land environment.

Their vertebral column is markedly convex, its function in the vertical direction being predominant over the lateral: It is no longer a bar whose lateral flexibility controls locomotion through the effect of muscles that cause the body's axis to undulate, but essentially a beam that serves as a base for the head and limbs. The latter are still bent but capable of raising the body above the ground during locomotion and the processes of capturing and swallowing. While it did not amount to complete freedom from pure crawling, saurian quadrupedal locomotion determined certain changes in the skull, as well as entailed considerable mobility of the shoulder and the definitive separation of the head which now moved at the end of a real neck.

The sauromorph skull comprises the same elements as those of earlier vertebrates and indeed oflater ones up to our own time. The cranium in cylindroconical section forms a kind of shell; the teeth are inserted along the edges in front, while at the back the external inion marks the junction with the braincase. The latter contains the brain and is articulated through the basion with the backbone; it is suspended from its top and sides by bony bridges inside the cranial vault. It is important to note that the volume of the cranial vault is not determined by the brain but by the mechanical stresses of mandibular traction and suspension of the head. The position of the brain, on the other hand, is determined by the basion because the end of the vertebral axis coincides both with the extremity of the spinal cord and with the point at which the skull is pivoted upon the body, while its volume is immaterial provided it does not exceed that of the structure itself. This explains the fact that from the fish to the dog, the ratio between the volumes of the face and of the cranial vault varies but little (the proportions being determined by the tooth row-to-muscle ratio of the mandible), whereas the volume of the brain increases considerably. The sauromorph's braincase is thus suspended inside the cranium, and there is still a long way to go before the braincase and a mechanically constrained cranial vault coincide exactly.

Besides the cranium the land vertebrate's skull comprises the mandible and the hyoid skeleton. Both of these are remnants of the gill mechanism of primitive fish, the mandible from earliest times, the hyoid arch from the moment of the establishment of aerial respiration. The hyoid skeleton is very important because it serves as a bony attachment for the muscles that lower the jaw and move the tongue. The amphibians, and especially the early reptiles, were the first to possess a structural mechanism whose role in capturing, mastication, and deglutition via the mandible, the tongue, and the pharynx would, as we shall presently see, culminate in the conscious phonation of human speech.

The mechanical properties of the sauromorph reptile's cranial apparatus are very striking. Basio-iniac suspension imposes a constant stress except when the animal is at rest upon the ground. The cervical vertebrae have lengthened, and the base of the skull, having become broader, serves as insertion for muscles that control movement in all directions. A robust ligament attached to the occiput and the vertebrae raises the head elastically. The musculature of the mandible is powerful, creating strong traction stresses that condition the proportions of the tooth row and cranium. Thus a law of proportions, which will remain in force for all vertebrates including humans, becomes apparent for the first time: The distance between prosthion and basion (the front and back of the skull) is divided into two equal halves, one dental and the other cerebral. The halfway mark between the prosthion and the basion therefore corresponds to the last tubercle of the last tooth, and constitutes the geometrical center of the cranial structure. Exceptions occur in certain types of skull, for instance, in ruminants where the dental cranium is longer than the cerebral one; the structural center has doubled as if an additional strip had been inserted between the skull's two halves.

Thus the sauromorph condition represents the earliest stage of the basic structure of land vertebrates. If we consider the extent to which the mechanism of the human body remains subject to the same constraints, we realize that most of the journey is already done: The vertebral axis acts as the main beam of the body's edifice, the limbs have separate identities in a skeleton of definitive design, the extremities have their five digits, the skull, suspended upon the basion, is raised by muscles and ligaments attached to the inion, the tooth row controls the volume of the cranium and its dimensions are also conditioned by the complex mechanism of the posterior cranium. The full set of interactions is already in place. Only the brain, modest tenant of the cranial cavity, plays a mechanically passive role. The apparatus that it will presentlyanimate is there at its disposal, but its role in the evolution of forms is not immediate or direct, making itself no doubt felt in the Darwinian selection of the fittest forms but not, so far as we can see, providing any mechanical impetus. It is in this sense that I regard the development of the brain as an element incidental to evolution in general. This in no way detracts from the well-established truth of the nervous system's evolution toward increasingly complex structures. Between the evolution of the brain and that of the body there has been a dialogue from which both sides have benefited. Evolution can of course be viewed as the triumph of the brain, but it is a triumph subordinated to certain overriding mechanical realities. In the progression of the brain and the body, at every stage the former is but a chapter in the story of the latter's advances. We cannot cite a single example of a living animal whose nervous system preceded the evolution of the body but there are many fossils to demonstrate the brain's step-by-step development within a frame acquired long before.

Theromorphism

Toward the end of the Permian period, before the end of the Paleozoic era, an event of capital importance took place: Reptiles achieved quadrupedal locomotion, and their limbs took on the appearance of those of the dog or elephant, that is to say, of pillars carrying the body high above the ground. Conjointly with this, the cervical vertebrae lengthened, and the neck became capable of moving the head within a relatively wide field. Once again, the advance was a step toward increased mobility, the expansion of the operational field, and the occupation of greater space. That any known species, or possibly even any known order, forms part of the human genealogical tree is uncertain and indeed unlikely. But the general tendency of all living species to expand their sphere of activity inevitably passes through the same stages, and it would not be difficult to describe comparable evolutionary stages in the world of the invertebrates, which has no genealogical connection with humans whatever.

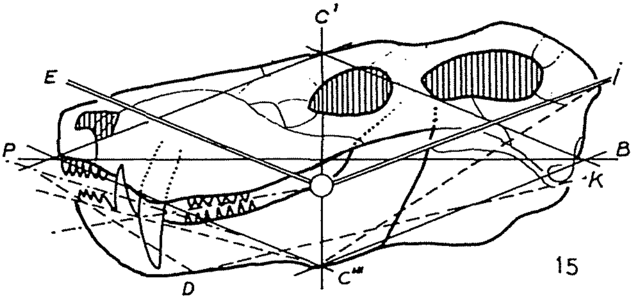
The theromorph stage is a major one from the double point of view of the evolution of the hand and that of the skull. Its development has been continual from the end of the Paleozoic era to this day and encompasses not only a great number of reptiles now extinct but also the totality of mammals, both fossil and living, with the sole exception of the anthropoid apes. For the sake of greater clarity we shall consider the theromorphism of reptiles before that of quadrupedal mammals.

Theromorph Reptiles

The end of the Paleozoic and the beginning of the Mesozoic eras, between 200 and 150 million years ago, were the time of the emergence and development of theromorph reptiles (figure 14). They included no dinosaurian giants, the largest among them being not much bigger than a wild boar, but their evidence, preceding the earliest mammals by fifty million years, is impressive. Their general appearance is one with which the mammals have familiarized us: Their vertical limbs rest upon the tips of their digits like the pig's or open out flat like those of the badger, whom they generally rather resemble, so that it is easier to imagine them furry than scaly.

The most striking characteristic is their skull (figures 15 and 16). In a number of them the general outline is that of a carnivorous mammal (figures 17 and 18): The back of the cranium is powerfully constructed, a thick temporal arch suggests the zygomatic arch of the mammals, the mandible resembles a dog's. Still more surprising are the teeth. Fish, amphibians, and reptiles had until then possessed—as they generally still do—a dentition of the conodont and homodont type; that is to say, their teeth were simple, conical, and all approximately identical with each other. Theromorph reptiles also have conodont teeth, but their teeth are of different proportions, forming three groups like our incisors, canines, and molars. This differentiation suggests an elaborate mode of capturing, breaking up, and masticating food, which is a characteristic of the higher vertebrates. The head's acquisition of an appreciable field of movement is thus matched by an equally pronounced technical specialization of the teeth. This fact might appear to represent a simple juxtaposition

15–18. Parallellism of functional evolution of the skull of theriodont reptiles (figures 15 and 16) and of the earliest carnivora (figures 17 and 18). Figure 15: Scylosaurus, *Permian period, late Paleozoic Era. Figure 16:* Cynognathus, *Triassic period, early Mesozoic era. Figures 17 and 18:* Vulpavus *and* Limnocyon, *Eocene epoch, early Cenozoic era. Despite*



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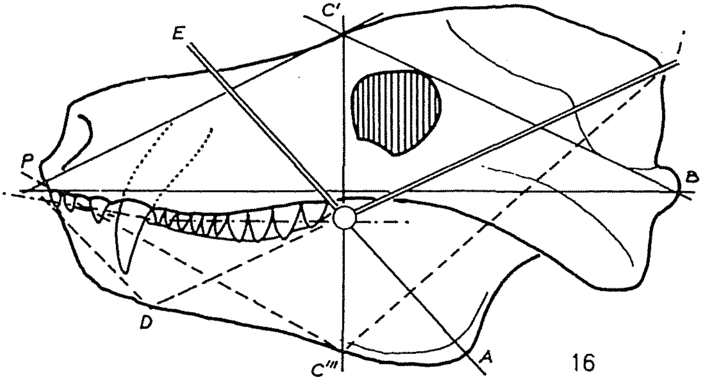

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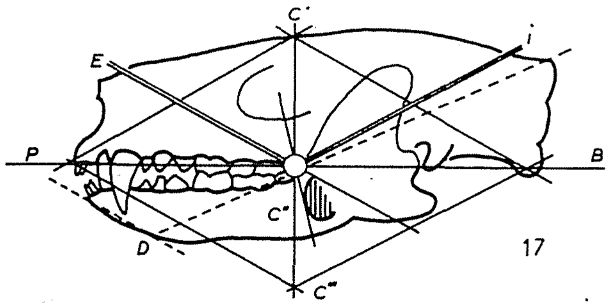

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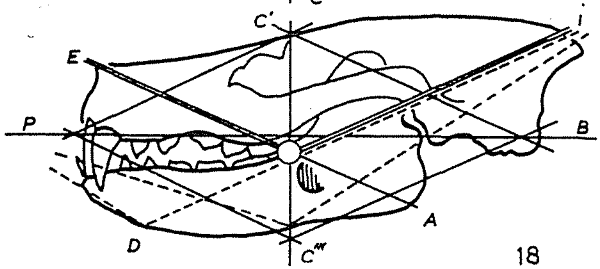

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the enormous time difference between the two zoological groups, their mechanical characteristics resemble each other because the functions are identical. Note, in particular, the elongation of the tooth rows and their specialization into incisors, canines, premolars, and molars. All angles are still of the same width. The shape of the skull is determined by purely mechanical factors, and the brain occupies only a small part of the cranium, especially in the reptiles.

of progressive characteristics, but in reality the structure of the skull reveals a profound relationship between heterodonty and postural changes.

The skull obeys the fundamental law of equal division between the dental and cerebral parts, but the length of the basilo-iniac lever has reached its maximum and the back of the skull forms a wide area of insertion whose bony reinforcements abut on the mandibular joint, giving maximum resistance to the effects of forces exerted by the mandible. The maxillodental apparatus has acquired a complex mechanical structure that divides the lines of force between the front teeth (used to seize food) and the cheek teeth (used to crush it). The roots of the canines at the front of the head form the structure of the muzzle, and their alignment when the mouth opens has repercussions on the whole architecture of the back of the skull. The geometrical structure of the lower species has been succeeded by a complex mechanism, likewise consistent in all its parts but so highly developed that the same principles of design will eventually apply, with the necessary adaptation, to the human skull.

Reviewing the evolutionary development thus far, we see that crossopterygians developed during the Devonian and Carboniferous periods, that the origins of amphibians date back to the same time, and that the first sauromorphs originated in the Permian period, as did the first theromorph reptiles. Thus the problem of the evolution of the higher vertebrates' body structure was raised and resolved between 300 and 200 millions of years before our time. By the end of the Mesozoic era there was practically nothing more to add: Yet mammals proper still loomed very far ahead in the future. There is surely a parallel to be drawn between this situation and the precocity with which the anthropoid apes freed their hand and achieved erect posture long before their brain had reached the level of ours today. This supports the hypothesis I have already defended, namely that the development of the nervous system follows in the wake of that of the body structure. Theriodont reptiles had the bodies of carnivorous mammals, but their brain was still no larger than a fountain-pen cap suspended inside an edifice whose entire inner space would be filled, two hundred million years later, by the brain of a dog.

Quadrupedal Mammals

In the essential aspects of their bodily structure, quadrupedal mammals do not differ from theromorph reptiles. Indeed there can be little doubt that the latter were the source from which they developed in a real new beginning. The first forms were lowly creatures of the middle of the Mesozoic era, which took some hundred million years to give rise to the flood tide of mammals in the Cenozoic era.

Walking and Grasping

If, leaving zoological systematics aside, we consider only the dynamic behavior of mammals, we observe two major trends: In some mammals the hand plays a part (which may be more or less important) in the operations that take place within the anterior field of responsiveness, while in others the head alone is involved. This creates a division between mammals that are exclusively walkers and those that are, at least temporarily, graspers. These two functional groups correspond to a very far-reaching separation of anatomical and behavioral characteristics—a separation into two worlds bound for different destinations, or, to put it differently, two separate responses to a fundamental choice.

Walking mammals (figures 19 to 21) are herbivores. Their extremities are narrowly specialized for walking, and the architecture of their skull is common to all forms. Many of them have organs peculiar to their species and derived from different anatomical facial areas: the frontal horns of hollow-horned ruminants, deer, and giraffes; the epidermal nasal horns of the rhinoceros; tusks; the canines and incisors of the hippopotamus; the canines of Suidae (wild boar, warthog, pig deer), Tragulidae (musk deer), camels, and walruses; the incisors of elephants; the elephant's and the tapir's trunk-shaped nasal appendages; the extensible lips of sirenians and numerous herbivores.

Grasping mammals are omnivores or carnivores. Their extremities are equipped with four or five functional digits, their forelimb is capable of grasping; many can sit and so free their hands; their skull has the same architecture as theromorph reptiles, gradually modified by postural development; lastly, they have no particular facial appendages. The exceptions are few in number but very characteristic, such as the elephant (figure 21) which is herbivorous but possesses a regular "hand," and the dog (figures 22 to 24) which is carnivorous but has limbs specialized for walking. In both cases the design of the skull follows the functional type of the hand. The elephant is one of the rare herbivores to possess a tooth row of medium length; the Canidae in general and the dog in particular are alone among the carnivores in having a long tooth row. The elephant's skull is short and its design unique, as indeed is the animal itself, being a "facial grasper." The dog's skull hardly differs from that of herbivorous quadrupeds.

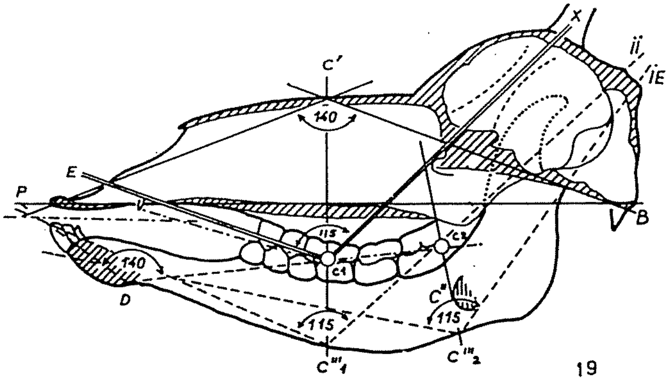
The most striking case is that of "rodents," which are divided into two groups, one completely herbivorous (such as the hare) and with no prehensile capacity whatever, the other omnivorous (such as the rat); in the latter, seated posture and grasping play an important role.

Thus the study of mammals raises from the outset the problems of the hand and the face and of the posture when grasping. In reality the three problems form a single one, which has a bearing upon the design of the human body. Because their history is so instructive, we shall briefly consider the walking theromorphs before leaving them behind on the path assigned to them by evolution—a dead-end road from the point of view of human development.

In the Eocene epoch, the first of the Tertiary period, some fifty or sixty million years ago, there emerged a large number of mammals that are regarded as the ancestor of orders still living today. Of modest size, like rabbits or sheep, they had widely generalized characteristics—five digits at the extremities, rather unspecialized crushing teeth, and a fairly uniform low and elongated shape. The separation into graspers and walkers had already taken place, probably a long time earlier. Although no true felines, true canids, true horses, nor rhinoceroses existed as yet, examination of skeletons shows that these mammals were separated into the theromorphs' two principal groups, and even the group of primates is already differentiated.

Walking mammals, both fossil and modern, are characterized by their long tooth row suitable for processing leafy plants. There is little doubt that at the origin of this adaptation there were forms with a normal tooth row ending halfway between prosthion and basion, the skull of walking mammals being constructed around a geometrical center to which a second center has been added at the back of the molars. The cranial appendages—horns or antlers—are integrated within the general mechanical system in accordance with designs that vary from one species to another but always remain extraordinarily consistent. It is not the fashion today to praise the ingenuity of nature, but when we analyze the mechanical solutions reflected in the skulls of the horse, the deer, the camel, or the rhinoceros, we cannot help being surprised by the way in which the same basic design provides answers to so many dissimilar demands. The structure of the skull of grasping mammals abounds in astonishing solutions in the accommodation of the brain and the canines,

19–21. Typical skulls of walking mammals with cranial appendages. In the stag (figure 19) a second center (C2) is established as a result of a herbivorous diet, which produces an elongated jugal tooth row. Note the corresponding angles of the incisors (140 degrees) and the molars (115 degrees) and the manner in which the lines of support of the antlers (C1–X) have been borrowed as lines for the absorption of mandibular pressures. The brain occupies all the available space. The single-horned rhinoceros (figure 20) has jugal teeth only; an interesting phenomenon is that in contrast to the stag, it has horns that serve as lines of absorption of mandibular pressures (E–C). The elephant (figure 22) also has no canines and absorption is oriented toward the base of the tusks and of the trunk; this fact accounts for the highly aberrant construction of the cranium.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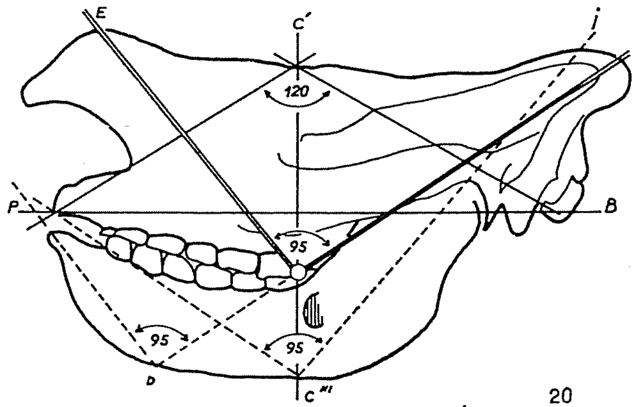
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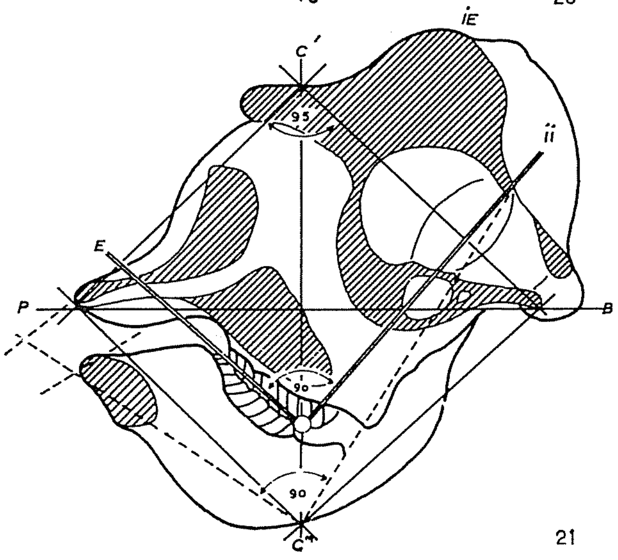
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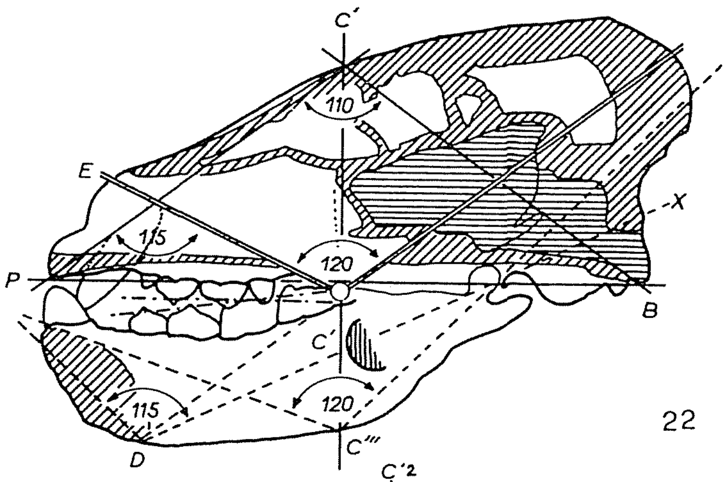

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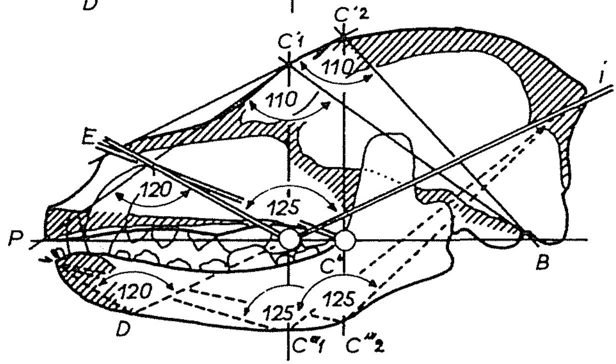

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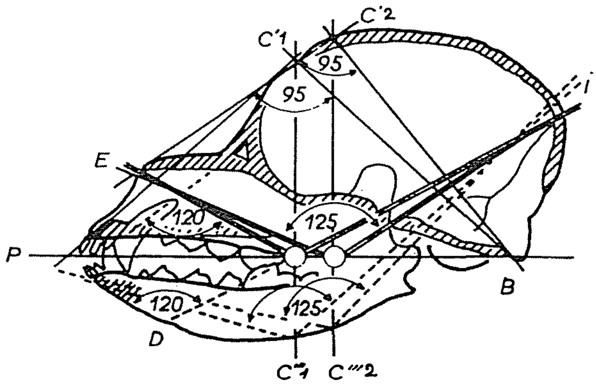

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22–24. Expansion of the brain in carnivores. Hyena *(figure 22), setter dog (figure 23), Pomeranian dog (figure 24). These three examples show that cerebral expansion is a secondary phenomenon ascribable to mechanical stresses. The hyena's brain is minuscule, and the empty space between it and the shell of the cranium is filled with sinuses. In a dog of average size (figure 23) the brain almost fills the skull, with a large sinus occupying the* but it does not have to cope with the same problems as that of the walkers, where there must be a compromise between a gigantic tooth row and the whole facial apparatus from which the skull has not yet been freed by the hand. In walking mammals, where everything is concentrated in the cranial edifice, the variety and subtlety of highly developed technical operations is reflected in great complexity of design.

In the graspers complexity is shared between the face and the hand. The general framework of the apparatus remains relatively simple. The five-digit hand, inherited from the amphibians of the Paleozoic era, has not undergone profound elaboration like that of the ox or the horse. The shoulder maintains its lateral mobility—the radius and cuneiform, instead of fusing with other bones, develop possibilities of supination; the skeleton as a whole develops toward greater flexibility of movement. The cranial design of theromorph graspers, for the most part carnivores or rodents, is balanced in a very simple manner: The law of division between cerebral and dental cranium remains constant. Their organization, in the most highly developed species, has reached the highest point compatible with quadrupedal locomotion; in forms such as the beaver, the rat, or the raccoon the level of manipulative activity is very high.

Pithecomorphism

The zoological ladder as established by zoologists reflects not only clear-cut differences between groups of animals but also links between them so that a little of the quadruped can be recognized in the monkey and a little of the monkey in the human. This approach, as we have seen in chapter 1, led to the evolutionary ideas predating the birth of paleontology according to which the monkeys were a morphological halfway house between ourselves and the theropods. From the functional point of view, four-handed animals as a whole constitute a very distinct group, as far removed from quadrupeds as from bipeds, based on a unique postural apparatus that allows alternately for grasping locomotion and for a more or less erect seated posture. Such temporary freeing of the hand as exists in grasping theromorphs is similar but functionally not identical. Monkeys and apes in fact are the only mammals that possess constant grasping ability both during arboreal locomotion and when

frontal space. In the Pomeranian the cerebal and mechanical factors have been reconciled, and the whole of the available space is filled by the brain. The base of the skull and the position of the basion remain unchanged (quadrupedal posture), but the frontal part of the brain considerably overhangs the facial bloc. Canine evolution illustrates the same phenomena at the quadruped level as human evolution at the level of bipeds.

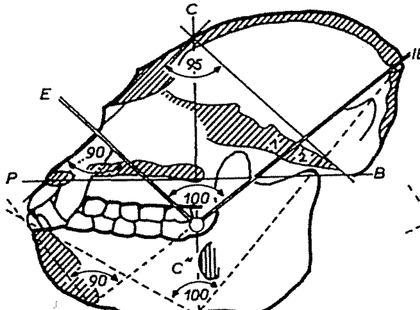
manipulating objects while seated. All other tree mammals hang on more or less by their claws instead of grasping the branches between the fingers and the opposable thumb. Grasping occurs among rodents and carnivores, but this also is gripping with claws.

These facts bring into focus the close connection between locomotion and grasping. The latter depends upon the characteristics of the former. In monkeys both the front and the hind "hands" are instruments of locomotion, but only the front hand is a *technical* instrument. Locomotion using grasping distinguishes monkeys among primates, just as bipedal locomotion characterizes the apes. Pithecomorphism is therefore characterized principally by a postural liberation due to four-handed locomotion. The other characteristics, important though they are, are corollaries.

The link that connects all the primates' characteristics with their locomotory apparatus hardly needs to be brought out still more clearly. Nonetheless, we might consider a series consisting of the hand of the colobus monkey, the guenon monkey, the macaque, and the gorilla in order to realize that the development of increasingly precise and efficient mechanisms for opposition of the digits corresponds to a form of locomotion based more and more upon the hand's preeminence over the foot in grasping operations, to a more and more erect seated posture, to a progressively shorter tooth row (and face), to more and more complex manual operations, and to a more and more highly developed brain.

This unity of functional characteristics is exactly reflected in the primates' cranial structure (figures 25 to 27). Remember that the fundamental connection between skull and body skeleton is the *basion* or front rim of the occipital foramen. Located at the back of the skull in theromorphs and all lower vertebrates, the occipital foramen of apes opens obliquely downward. This position is the direct consequence of a postural ability that relies on the presence of a vertebral column capable of adjustment to both a seated and a quadrupedal position. In the series of monkeys and apes listed earlier, the position of the occipital foramen is directly related to the

25–27. Evolution of the skull structure of monkeys. Colobus (figure 25), baboon (figure 26), orangutan (figure 27). The Colobus monkey, with its reduced thumb, is an "arboreal quadruped"; the baboon practices quadrupedal locomotion on land; and the orangutan practices quadrimane locomotion in trees. In all three animals seated posture is of considerable importance and is reflected in the position of the occipital foramen (oblique at the back of the skull). The most important fact is that the P–C′–B frame has shifted from the convexity to the face. Note, as in figures 25, 26, and 27, the shift of point C′ to the prefrontal bloc. The base of the skull becomes gradually integrated in line C′–B and corre-



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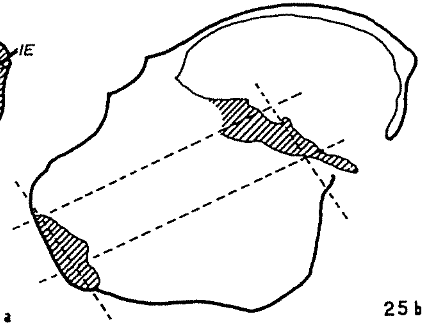

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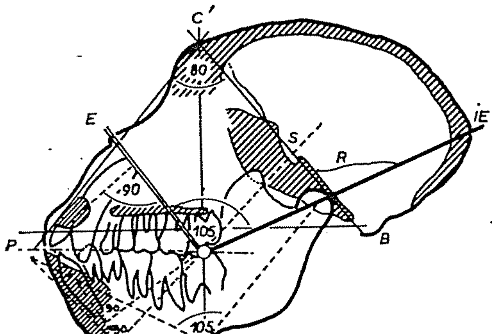

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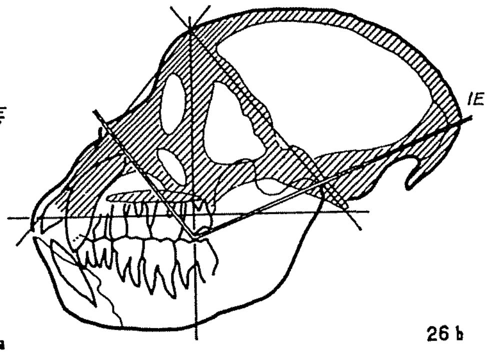

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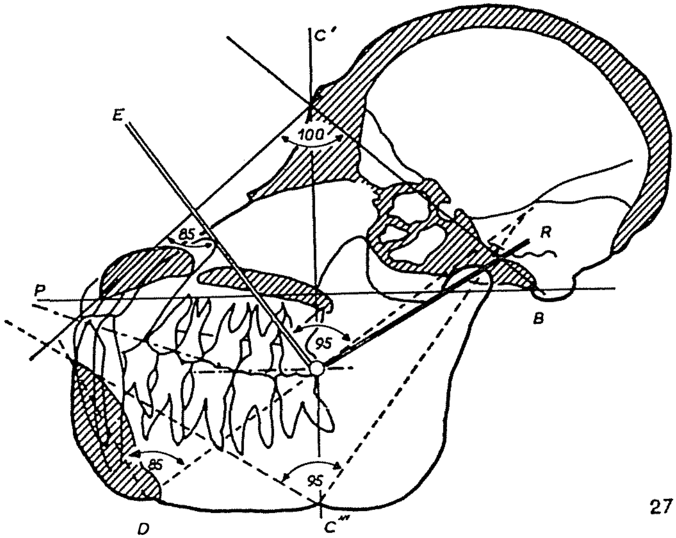

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sponds directly to the axis of mandibular stresses (figure 25b). As a result of this, the brain (figure 26b) along the entire convexity is free. It is, however, still constrained by the external inion (IE) and barred in front by the orbital bloc, which has become the keystone of the facial structure.

degree of erectness in both positions, so the gorilla is as upright in the quadrupedal position as the colobus monkey is when seated.

In all primates the relationship between the occipital foramen and vertebral posture, though in itself a banal fact, entails a number of highly important consequences for the skull. The prosthion-basion base is considerably shortened; that is to say, the tooth row and face are much shorter than in theromorphs. The basion-inion lever is lower down, and for the first time in the animal kingdom, the cranial dome is partially freed from the stresses of cranial suspension. The connection between this mechanical fact and the development of the brain will be seen in the next chapter. While the cranial dome is thus freed from suspension stresses, the base of the skull escapes from the traction stresses of the mandibular apparatus, and the facial unit becomes independent of the cerebral part of the cranium. The facial part is contained inside a triangle that connects the prosthion with the basion and with the orbital ridge. This explains the compact osseous mass which, in primates, forms a "visor" above the face. The disengagement of the cranial dome is thus achieved from the back of the skull; the prefrontal area in all primates, as in the primitive anthropoids, is locked in position by the eye sockets (the orbital bloc). In the next chapter it will be seen how, in anthropoids, further restructuring of the facial edifice brought about the gradual disappearance of the frontal visor and the frontal expansion of the cranial dome.

General Thoughts on Evolution up to the Primates

Whether their beliefs be metaphysical or rationalist, whatever explanations they may offer, all evolutionists agree that the stream upon which we are borne forward is *the* stream of evolution. Like the giant dinosaur, the lichen, jellyfish, oyster, and giant turtle are no more than spray from the central jet that gushes human-ward. Supposing even that one chose to consider the categories of animals ranked behind humans as representing only one evolutionary track (that leading toward intelligence, with others toward different, no less honorable heights), evolution toward the human state is a fact, and we are entitled to select the links that illustrate it.

Whether, as in Bergsonian or Teilhardian philosophy, evolution is seen as an upsurge, a general striving for consciousness that ultimately led to *Homo sapiens,* or (what comes to the same thing for the objects involved) as the play of determinism producing living forms ever more adapted to the exploitation of matter, the behavior of the mass from which the human has emerged remains the same. Beneath the superstructure of explanations, the infrastructure of facts is reduced to the same system.

The living world is characterized by the physical and chemical exploitation of matter. Two modes of exploitation appear at the two extremes—one involving the utilization of matter through direct confrontation of the exploited molecule by the exploiting one, as with viruses, and the other being a hierarchical form of consumption that exploits inert matter via a chain of living organisms, as with the human eating beef at the end of a long series of eaters and eaten. The second mode is actually identical with the first in that it ends in a confrontation of molecules inside the eater's body. But the point is that, for a good billion years or so, certain living beings have been engaged in a search for conscious contact.

The whole of evolution boils down to this search. All spirituality and all philosophical and scientific exploration are the end goal of the same search for contact, which is governed by the mind. At all levels such contact is achieved through the two coordinated structures of the body and the nervous system. For many evolutionists—Teilhard de Chardin for one—the significant fact is the ever-increasing development of the brain and its associated structures. Since the brain is ultimately the physical seat of thought, and since it is in this area of evolution that the human being has been most successful, there are formal grounds for believing that the increasing size and complexity of the cerebral apparatus exactly reflect the steady progress made by living matter in its striving for conscious contact. We must recognize too that the body and the nervous system form a single whole and that to separate them would be artificial and arbitrary. Yet this petitio principii appears to provide only an incomplete answer to the problems raised by the evidence at hand. The human being undoubtedly constitutes a whole, but the human body and the manifestations of the human mind have always been perceived as distinct. Our religions and philosophies have been fed on this distinction. Whether the brain is the organ or the instrument of thought makes no difference to the relationship between the body and the subtle network of fibers that animate it. Materially, evolution is reflected in a double set of facts: On one hand, the cumulative improvement of cerebral structures and, on the other, the adaptation of bodily structures in accordance with rules directly related to the physical constraints of this machine which is the living, moving organism. The relationship between brain and body is one between the contained and the container. Every imaginable evolutionary interaction may occur between them, but contained and container cannot, by their very nature, be identified with each other.

Proof of this is provided by the historical sequence of the fossil records. Mechanical systems like those of quadrupedal vertebrates crop up very early, animated by a very small brain. Once a specific mechanical solution has been reached by a number of groups, each using its own means to reach it, we observe a gradual enhancement of the brain and an improvement of the mechanical apparatus by a series of adaptations in which the brain obviously plays a role, but as a determinant of advantages in the natural selection of solutions rather than as a factor directly orienting physical adaptation. The evolutionary ceiling is reached when the volume of the brain equals the whole of the space available to it. Each species then enters upon the stage of its full achievement, which in many cases seems to correspond to a prolonged standstill. That, at least, is the case with such groups as herbivorous mammals, whose paths toward further mechanical adjustment appear to be blocked. In other groups, however, the structure of the body remains capable of revolutionary adaptations, and paleontologists have long recognized that it is the least specialized groups that have produced forms with the most advanced cerebral features.

This aspect of evolution accentuates the close connection between the two respective trends of the nervous system and of mechanical adaptation. In primates, for example, the four-handed formula corresponds to an extreme specialization of the body but is based upon the preservation of the pentadactyl limb of primitive vertebrates. This adaptation is in principle the same for all four-handed animals, but it shows considerable internal variation between one species and another in terms of behavior, active postures, and physical structure. Those whose body structure corresponds to the greatest freeing of the hand are also those whose skull is capable of containing the largest brain, for manual liberation and the reduction of stresses exerted upon the cranial dome are two terms of the same mechanical equation. For each species a cycle is established between its technical ability (its body) and its ability to organize itself (its brain). Within this cycle, through economy of design, a way opens up toward increasingly pertinent selective adaptation. Thus the chances of evolutionary development are the greater, the better the body apparatus lends itself to changes in behavior through the action of a more developed brain. In this sense the brain does control evolution, but it remains ineluctably dependent upon the possible range of selective adaptation of the body.

These are the reasons why, in considering evolution, I have chosen to focus first on the mechanical conditions for development. The volume of verifiable facts available in this area is not to be scorned. When the same consequences of mechanical stresses are found reflected in the same structural principles in a hundred species, it becomes possible to pinpoint certain conditions without which cerebral evolution would remain an abstract phenomenon.

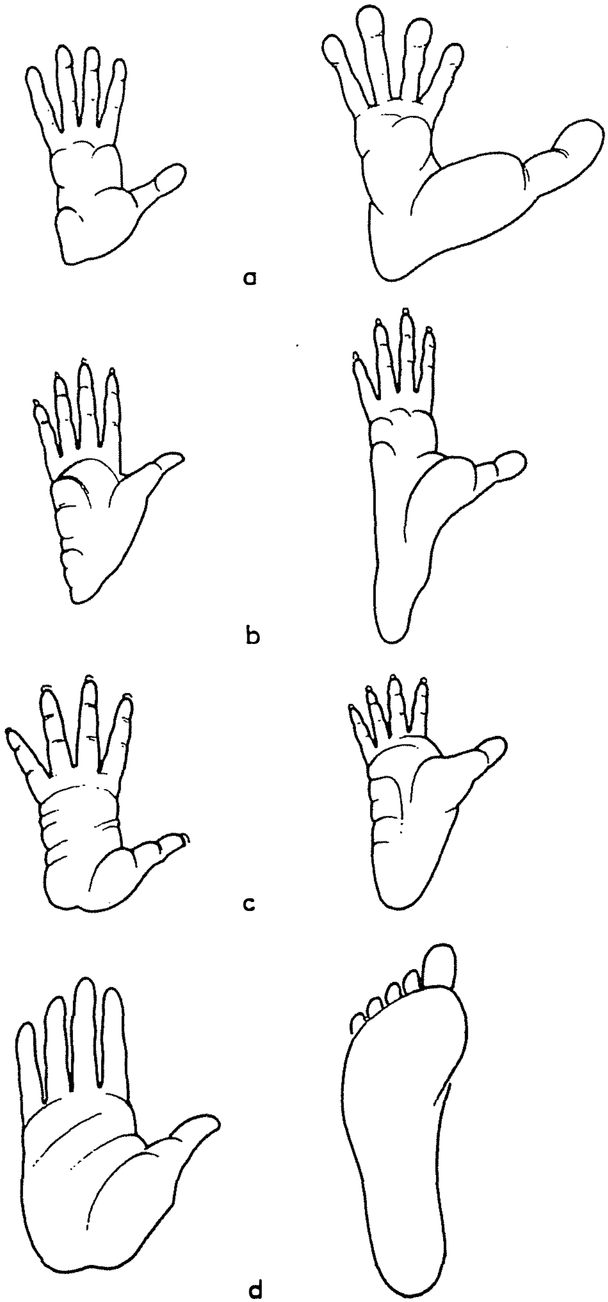
3 Archanthropians and Palaeoanthropians

Anthropomorphism

Nomenclatures always embody traces of the past, sometimes to their detriment. The nomenclature of human paleontology abounds in such traces; it is a fabric of concepts which, in the course of time, have gradually become outmoded. Pithecanthropians, Prehominids, Australopithecinae, are all labels hallowed by tradition but whose etymology we should beware of accepting uncritically. More venerable still, the expression "anthropomorphic" presupposes a link between the great apes and humans. A legacy of the eighteenth century, it is the most questionable term, for only a being that shares our erect posture and its multiple consequences can be said to be truly anthropomorphic. Functionally as well as morphologically, anthropoid apes are pithecomorphs.

The formula for anthropomorphism is in fact different from the formula for monkeys and applies exclusively to the anthropoid family. Its fundamental characteristic is skeletal adaptation to bipedal locomotion (figure 28). This is reflected in a distinctive structure of the foot (the toes forming parallel radii, as in walking vertebrates), in certain structural details of the tarsus and the leg bones, and especially in the modified pelvis upon which the full weight of the trunk is balanced. The spine shows compensatory curves whose resultant is a vertical line. The forelimb is free, and the hand has the same parts as a monkey's but differs quite appreciably in its proportions and in what it can do. The head's essential characteristic is that it is balanced on top of the vertebral column.

This functional configuration is as different from that of monkeys as the monkeys' is from that of the theromorphs. Monkeys share with certain theromorphs the possibility of having a free hand when seated, but their opposable thumb and partly freed cranial convexity make them radically different from beavers or bears. Anthro-



28. Hands and feet of primates. (a) Lemur, (b) guenon monkey, (c) chimpanzee, (d) human. The human hand is not fundamentally different from that of other primates. Its ability to grasp, like theirs, is due to an opposable thumb. The foot, however, is radically different from a monkey's. A primary stage with an opposable big toe is conceivable, but the two paths must have diverged very early, before the earliest known anthropoid stage.

poids in turn share their seated posture and opposable thumb with monkeys, but their bipedalism and the complete freeing of the convexity of the brain make them so different from pithecomorphs that there is no more reason to bracket them together than there would be to regard the chimpanzee as a kind of highly developed raccoon.

The Anthropoids' Ancestor

Yet humankind's obsessive interest in the behavior of monkeys persists. A chimpanzee, were it capable of thought, might feel something similar when it watched a raccoon open a door or grab a pot of jam. The idea that just one more touch would suffice to turn a chimpanzee into some kind of not-quite-human is difficult to shed. Paleontology has demonstrated over and over again that no close link can be established between the chimpanzee and ourselves, forcing us to abandon the idea of a transitional *Anthropopithecus* and, a few years ago, to seek our origins in the depths of the Tertiary period of the Cenozoic era when the great apes as now understood could not have existed.

Hirzeler's research on *Oreopithecus* has confirmed the earlier intuitive idea that apes with humanoid tendencies existed as early as in the Miocene epoch, that is to say, the middle of the Tertiary period. As will be remembered, the discovery of an almost complete *Oreopithecus* skeleton in 1958 produced some sensational headlines in the world press ("Ten-million-year-old Adam," etc.). It is hard to say what this skeleton, sandwiched between two sheets of limestone and exceptionally difficult to reconstitute, will eventually reveal. The proportions of the body, which can be judged with a fair degree of certainty, are roughly those of a gibbon, with very long arms, a very long hand, and relatively short legs. The animal has no tail. It is unlikely to have been a terricoline one, as a remote ancestor of the anthropoids might be expected to have been, but rather a tree-dwelling animal specializing in brachiations, like the gibbon. This feature is of interest for two reasons: On the one hand, the gibbon is the only monkey that uses bipedal locomotion when on the ground; on the other hand, while doing so, it swings its arms backward in order to balance itself and therefore cannot use them when erect. Until more is known, all that *Oreopithecus* tells us is that in the middle of the Tertiary period of the Cenozoic era there existed a primate with a relatively short face and with long arms that may have enabled it briefly to stand erect.

Thus it might be thought that for thirty million years or so, between the middle and late Tertiary, creatures resembling the gibbon may have gradually abandoned tree-dwelling brachiation, have undergone shortening of the arm and modification of the foot, acquired a vertebral column upon which the skull was balanced, and achieved all this without going through the quadrupedal stage of modern anthropoid apes. Such a process is by no means unlikely. It would lead more or less directly to a creature resembling *Australopithecus,* but paleontological reality often outstrips paleontological conjecture. So we should not be overhasty in forming a picture of our true ancestor.

The "Australanthropians"

The discoveries of Dart, Robert Broom, and Leakey show that between the later Tertiary and the beginning of the Quaternary, Africa was extensively populated by bipeds who used tools and were much closer to the picture of our ideal ancestor than any previously discovered "Pithecanthropians." They have been given various names—*Australopithecus, Plesianthropus, Paranthropus, Zinjanthropus*—but are often grouped under the family name of *Australopithecinae,* an inappropriate term harking back to the still recent past when these bipeds were viewed as superior monkeys. In this book they are referred to as Australanthropians.

If we ignore the tangle of hypotheses concerning them that have been offered over the past thirty years and consider only the end results, particularly those obtained in the past five years,* we find that the picture, although revolutionary, is a perfectly consistent one.

These bipeds walked upright, had an arm of normal length, and made stereotyped tools by lightly chipping the ends of pebbles. They were partly carnivorous. This description, human to the point of banality, bears no relation to monkeys but is just as applicable to *Pithecanthropus* as to Neanderthal man. The only important difference, one of degree rather than substance, is the size of the brain which, in *Australopithecus,* is incredibly small—small enough to cause some embarrassment to the anatomist. We shall have occasion to revert to the question of the Australanthropian brain; consideration will here be confined to the principal features of the structure of the body and, in particular, of the skull.

With regard to the skeleton, no complete specimen of which has as yet been found, we possess numerous fragments obtained from a variety of sites in Tanganyika and South Africa. The most solidly established facts are that the pelvis and the femur, the erect skeleton's key elements, do not differ in any fundamental respect from

* Translator's note: It may be useful to remind the reader that *Gesture and Speech* was first published in 1964.

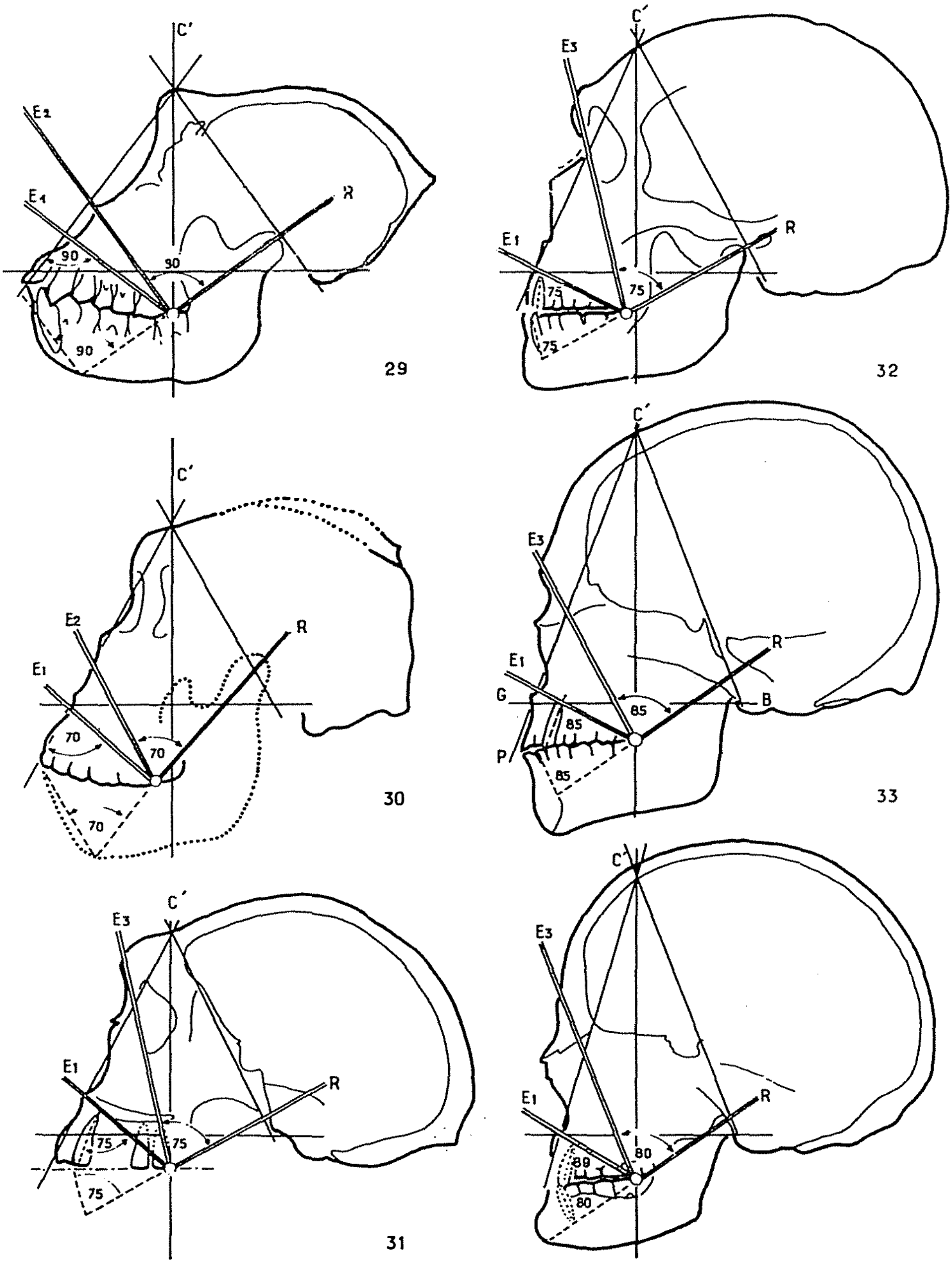
those of humans, and that the pelvis is so constituted as to support the abdominal viscera from below, a fact that offers categorical proof of bipedalism and presupposes a foot with a sole already well adapted to provide support for long periods. The cranium suggests precisely the same conclusion because the occipital foramen is located at the base. There are thus no grounds for refusing *Australopithecus* a place among the anthropoids.

Cranial Structure

The first impression on examining the skull of *Plesianthropus* or *Zinjanthropus* (figures 30 and 36) is that it is the skull of an anthropoid ape, a gorilla, or a chimpanzee: It has the same very long face, the same visorlike orbital ridge, and the same lack of a forehead. Closer study reveals enormously powerful development of the premolars and molars, incisors and canines proportionally weaker than ours but bearing no relation to those of monkeys, and a small braincase like a gorilla's but a well-rounded descending nape like ours with the occipital foramen opening downward. In some specimens, including the famous Olduvai *Zinjanthropus,* a bony crest like the gorilla's surmounts this minuscule box with its human contours, but instead of rejoining the point of insertion of the cervical ligament, it breaks off, leaving a wide, rounded area for the nape. No other relatively recent fossil gives such a strange feeling, almost of embarrassment—an impression of being in the presence of a nonhuman rather than of a monkey turning into a human. This uneasy feeling is due to the fact that the Australanthropians are really not so much humans with monkeys' faces as humans with a braincase that defies humanity. We were prepared to accept anything except to learn that it all began with the feet!

Close study of the structure of the Australanthropian skull is not an easy task, for two reasons. The first is the condition of the fossils: Only one Plesianthropian skull, other than that of *Zinjanthropus,* could be reconstituted sufficiently to allow investigation from the mechanical point of view. The second is that the two abovementioned skulls belong to individuals who were not fully adult, and their form is therefore not definitive.

Their configuration does, however, reveal a fact of capital importance: With the occipital foramen being situated below the cranium and not obliquely at its back (figures 29 to 34), the base line between basion and prosthion is appreciably shortened, and the size of the front teeth is reduced proportionally to the distance of the foramen's displacement. In other words, the area lost through the disappearance of prognathism equals the area gained at the base of the skull through the mechanical



29–34. Evolution of the support structure for the front teeth (incisors and canines). Pressures developed on the front teeth are absorbed inside the facial bloc in the direction of the orbital bloc and the basilar bloc (R). In the gorilla (figure 29) the orbital bloc, keystone of consequences of erect posture. To put it yet another way, an upright backbone means a shorter anterior tooth row.

The postural development of monkeys had the consequence of partially freeing the back of the skull from mechanical stresses by transferring the entire apparatus for the absorption of mandibular stresses to the facial bloc. The facial structure of the oldest anthropoids is not very different from that of the higher apes, but the back of the skull is completely disengaged. The convexity has been widened by about 60 degrees, which explains the rounded and very human look of the occipital region.

Thus *Plesianthropus* and *Zinjanthropus* meet the elementary conditions to qualify as anthropoids: The facial bloc is a triangle constituted by basion, prosthion, and orbital visor, as in monkeys, but the top angle tends to diminish, narrowing from 100 degrees in the orangutan, 90 degrees in the chimpanzee, and 75 degrees in the gorilla to 60 degrees in *Zinjanthropus,* 55 degrees in Palaeoanthropians, and 45 degrees in *Homo sapiens.* The Australanthropian orbital bar is still locked, as in monkeys, and the frontal part of the cranium remains very small: This was to be the last obstacle to the emergence of the modern type. Thus the forward region of the skull might be a monkey's were it not for the smaller anterior tooth row and, particularly, the smaller canines in response to the mechanical freeing of the back of the skull; the bearing length of the dental arch is in balance with the area occupied by the muscles of facial expression, especially the temporal muscles. The premolars and molars are enormous, and the space available for the insertion of the temporal muscles in the small cranial box is inadequate. Along the line at which they meet there is a bony crest comparable to the gorilla's but restricted by the top of the cranial convexity. We shall see further on that the situation has not yet lost any of its strangeness, for the brain housed inside this cranium is no longer a monkey's but that of a toolmaking

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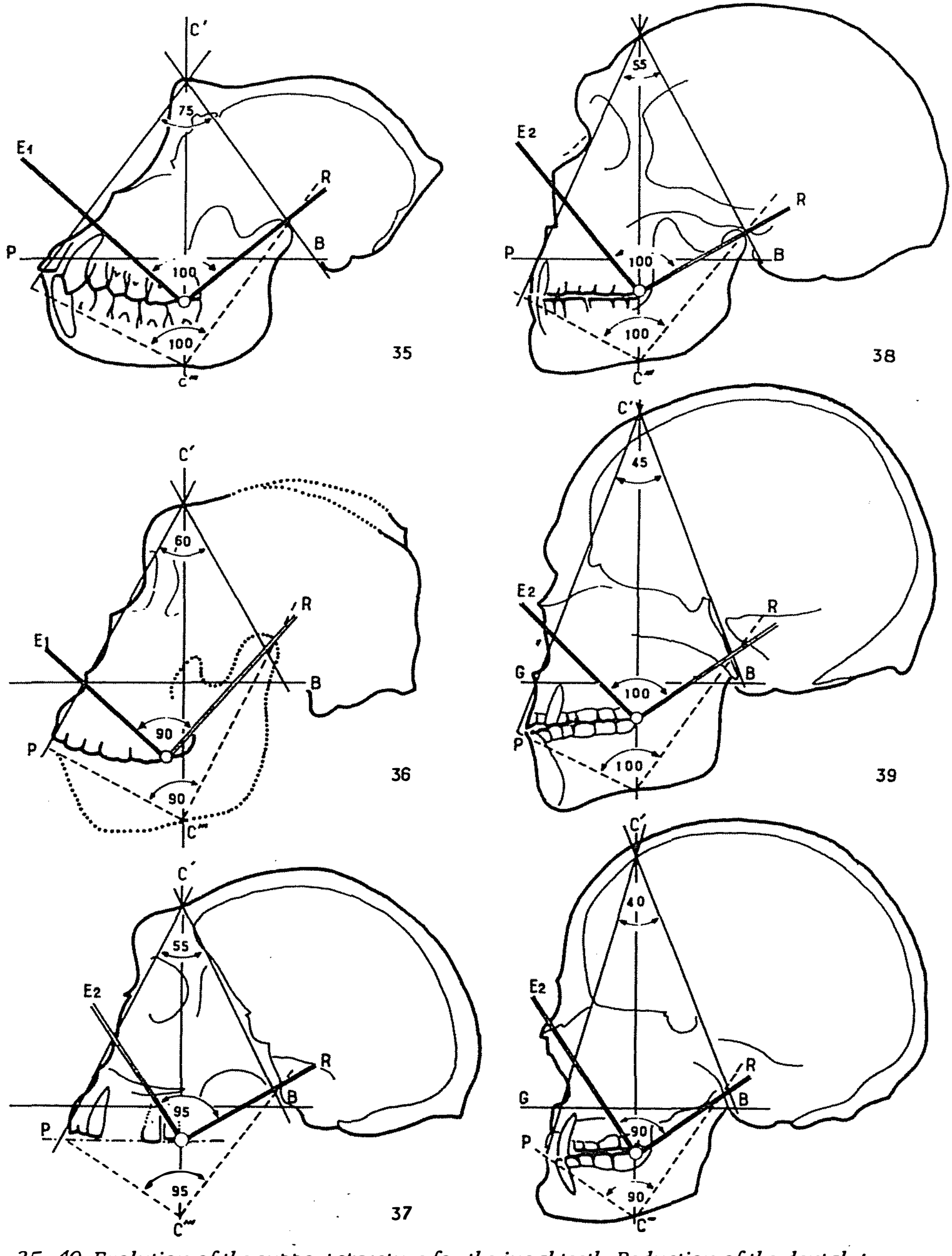
the cranium, lies outside the axis of absorption, and balance is established along the line E2, inside the lower edge of the orbit and the cheekbones, which are flat and perpendicular to the axis of the canines. In Zinjanthropus *(figure 30) the facial structure is of the same type but with narrower angles due to a shorter base, which in turn is due to erect posture. In Palaeoanthropians (Broken Hill [figure 31] and La Ferrassie [figure 32]), the top of the facial structure has shifted toward the convexity (C'), and the diminished heaviness of the face is reflected in the shift of anterior pressures directly into the orbital bloc. The space between E1 and E3 is flat and inclined toward the forehead ridge. In* Homo sapiens *(New Caledonian [figure 33], European female with the third molar missing [figure 34]) the apex C' has shifted farther back, and the facial overhang means that the area of absorption for the front teeth is now in the cheekbones, which have assumed the corresponding angle of inclination (canine fossa). The orbital area shares the axis E3 with the cheekbones, and its character as a prefrontal bar is gradually lost.*



35–40. Evolution of the support structure for the jugal teeth. Reduction of the dental structure is reflected in a progressive narrowing of the angle C′ from 75 degrees in the gorilla to 40 degrees in the European female. Balance of pressures is established at between 90 and 100 degrees, but the manner in which it is achieved varies from one species to another. In the gorilla (figure 35) and Zinjanthropus *the axis of the roots of the molars appears to be determined by the anterior system and correspnods to E1, the line of support of the ca-*

being. Every piece of information we receive from early anthropoids forces us to review our traditional ideas about our origins.

The Archanthropians

The fossils upon which theories had rested for two-thirds of a century were thus relegated to the background by the Australanthropian revelation. *Pithecanthropus, Sinanthropus, Atlanthropus,* the man of Mauer, all of whom had given rise to innumerable syntheses, were now seen only as intermediate links. *Zinjanthropus* conferred upon them a humanity so close to our own as to be almost banal. The important issues once raised by the Sinanthropians with their knowledge of fire, the Atlanthropians with their already elaborate tools, the Pithecanthropians with their femurs almost like those of modern humans were suddenly resolved by the distance of hundreds of thousands of years which the Australanthropians put between the origins of the human being and these Archanthropian witnesses. Although the Archanthropians still have a great deal to tell us, possibly of a surprising nature, there is practically no possibility of their disproving the fundamental fact that they were already the inheritors of a very long human past.

Yet their humanness remains disconcerting. Their face is enormous and their braincase is appreciably smaller than ours. Their forehead is still, in enlarged form, that of the Australanthropians, barred by a visorlike orbital ridge. Today they are no longer seen as the half-monkeys we once believed them to have been, but their cranial anatomy offers a telling picture of the stages of humanization.

The Palaeoanthropians

The links that matter most in a chain are the first and the last. The most important thing we need to establish is where the long chain of the anthropoids begins and how it links up with ourselves. It is the Palaeoanthropians, and particularly the Nean-

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nine roots. In the Palaeoanthropians (figures 37 and 38) the axis E2 corresponds to the lateral region of the cheekbones (pyramidal apophysis) so that the anterior support structure (figures 31 and 32) and the jugal support structure are in balance. Since in Homo sapiens *(figures 39 and 40) the support structure for the canines has shifted to the cheekbones (figures 33 and 34), the tendency is toward the establishment of a support area increasingly detached from the fronto-orbital bloc and concentrated in the area of the cheekbones. The female lacking a back molar shown in figure 40 represents the peak of cranial evolution achieved to date.*

derthalians, that form the link nearest to us. It may be useful to recall here that all classifications of this kind are somewhat arbitrary. Were we to have access to just twenty complete fossils between the Zinjanthrope and ourselves, there would be no question of Archanthropians or Palaeoanthropians but an unbroken progression from stage 1 to stage 20. Despite variations among contemporary forms we cannot, unless we insist upon clinging to certain outmoded concepts, find any significant inconsistencies or duplications in the handful of fossils whose dates are unchallengeable.

The old Palaeoanthropians are known to us only through a few skulls, most of them very fragmentary; the only more or less complete ones are those from Steinheim, Gibraltar, and Saccopastore I. The skull from Broken Hill in Rhodesia is not precisely dated, but it reflects an archaic state rather similar to that of the early Palaeoanthropians of Europe. Recent Palaeoanthropians are numerous, and several complete skeletons are known. Intact skulls, on the other hand, are rare and the majority have been reconstituted from very large numbers of fragments. Among them there are types such as that of Skhul, already very close to *Homo sapiens.* In Europe the best fossils are those of La Chapelle-aux-Saints, La Ferrassie, and Monte Circeo.

There is no need, at any rate here, to inquire into the differences between the structure of the Palaeoanthropian body and our own. Since the problem of more or less erect posture no longer arises, such an inquiry would have little point—and besides, with the available records it would hardly be feasible. Their cranial structure, on the other hand, is of the greatest interest because it reveals the last stages in the acquisition of the brain of *Homo sapiens.* To determine the exact form of the Palaeoanthropian hand or foot, to discover the small details whose interpretation may help to build up a living portrait of Neanderthal man is of course a task of the greatest interest from the scientific point of view, but it cannot offer a new solution to the problem, for we know that a humanly constituted body existed long before the evolution of the brain had been completed.

The Palaeoanthropian Skull

The classic portrait of Neanderthal man shows him with a low, wide skull, a receding forehead, enormous orbital ridges overhanging large orbits in a massive face, without pronounced cheekbones, the lips set very high, and the chin nonexistent (figures 31, 37, and 41). A powerful nape maintains this rude edifice on top of a thickset body mounted on a pair of broad feet. Give or take a few details around the forehead or the chin, flatten the skull a little, and this robot portrait will match every known specimen from the oldest to the most recent.

Unlike the Australanthropian, Neanderthal man is an anthropoid with a large brain. The discovery of this fact greatly disconcerted the paleontological community two generations ago. Indeed the volume of the braincase of recent Palaeoanthropians is no smaller than that of some races living today. However, as Boule and R. Anthony pointed out long ago, the relative proportions are not the same in Neanderthal man as in ourselves. The Palaeoanthropian skull is dilated in its occipital part, the forehead remaining narrow and low. This characteristic is self-explanatory if we consider what has been said about postural evolution from the monkeys to the humans. When the mixed anatomical system of primates with a seated posture became established, it was the back of the skull that benefited from the breaking of the link with the cranial case, but the effect of the transfer of the mandibular structure into the facial bloc was to bar the forehead behind the orbital bloc. With anthropoids, whose posture is erect, a considerable amount of space is gained as a result of what is sometimes rather incorrectly described as the "coiling" of the brain round the base. In Australanthropians this gain affects principally the occipital region and the area of the temples. The design of the facial bloc is rather the same as in primates: The forehead remains barred behind the orbits. Consequently the most important paleontological problem remains that of the freeing of the forehead in *Homo sapiens,* a phenomenon correlated with a thoroughgoing reshaping of the face in the course of which the forehead, the cheekbones, and the chin make their first appearance. This transformation is most clearly illustrated by Palaeoanthropian fossils.

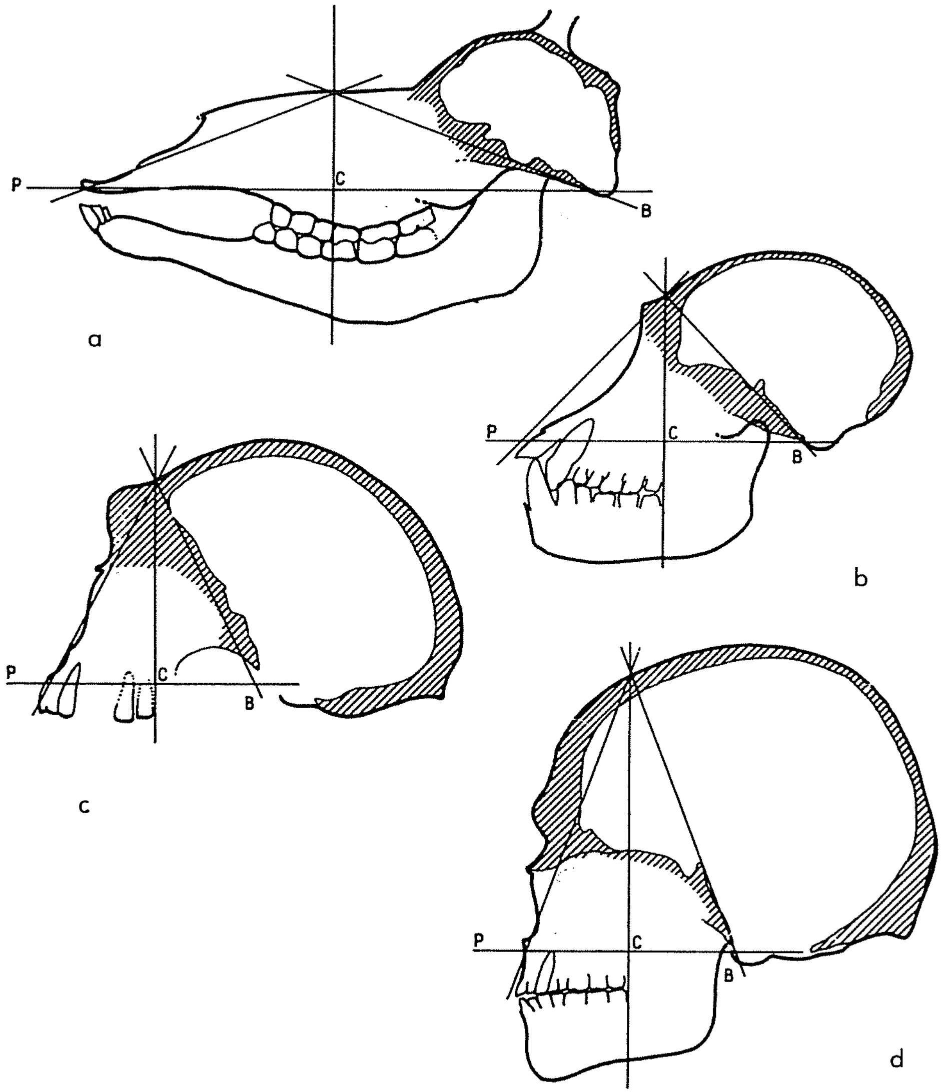
If we compare the diagram representing, respectively, *Zinjanthropus,* Broken Hill man, and La Ferrassie man, we are immediately struck by the progressive reduction in the size of the facial bloc relative to the braincase. It is as though, starting at the orbits, the face had begun to shrink and to be overthrust by an increasingly dominant braincase. This reduction in absolute prognathism is directly reflected in the facial structure, the apex of which is located in the center of the orbital bloc in *Zinjanthropus,* at the junction of the orbits with the forehead in Broken Hill man, in the middle of the forehead in La Ferrassie man, and almost behind the forehead in present-day man. The same development is attested by the gradual narrowing of the angle formed by prosthion and basion, which reduces from 60 degrees in *Zinjanthropus* to 45 degrees in modern man. It is also supported by the following observation: In the course of anthropoid evolution the supraorbital bloc progressively loses its function as the base of the facial structure diminishes in size until it disappears altogether, for instance, as may be seen in most females today. In short, it is as though the brain had come gradually to occupy the anterior territories as these became free from the mechanical stresses of the face.

One might claim the opposite by saying in more classical fashion that the frontal development of the brain determines the progressive reduction in the size of the face. In my view, however, this puts the cart before the horse by subordinating a mechanical effect to causes of cerebral growth, which are quite impossible to demonstrate. Indeed the contrary is proved by the fact that the most highly developed Palaeoanthropians with their 1,600 cubic centimeter brains really do look like the result of a mechanical compromise, the expansion occurring toward the back and sides of the skull where stresses are nonexistent. If the brain really had the expansive force it has been thought to possess, there would be no reason why the forehead should not have developed much earlier, even over jutting orbital arches.

Other factors would seem to be responsible. We should recall that heterodonty—or diversification of teeth into incisors, canines, premolars, and molars—appeared toward the end of the Paleozoic era at the same time as off-the-ground quadrupedal posture. Let us recall too that from that moment onward the root of the canine becomes one of the key elements of facial structure. Even in species such as the horse, where the canine is almost completely regressed, it remains linked with the general structure. In monkeys the root of the canine continues to play the same role irrespective of the size of the crown of the tooth and forms a continuation of the bony grooves that join the orbital bloc. In other words, the face is constructed on four pillars (two formed by the first molars and two by the canines), with the key located inside the supraorbital bloc. This design, as we have seen, is still present in Australanthropians, but the shortening of the base due to the erect posture means that the proportions of the root of the canines are appreciably reduced.

The process of adaptation of the cranial edifice continued slowly until the emergence of the modern human. This development would normally be connected with a corresponding postural one, as I implied earlier when speaking of a possible adaptation of spinal curvatures. The principle of erect posture, now attested by numerous fossils, however, is not in doubt.

The evolutionary process is once more apparent in the close connection between the gradual shortening of the base supporting the cranial edifice, the diminishing size of the tooth row, and the expansion of the brain, which spreads to those areas that offer the least resistance (figures 29 to 41). Progressive reduction in the size of the canine root is very pronounced in all dated Palaeoanthropians. In the case



*41. Shortening of the skull base and expansion of the brain. Deer (*a*): In the ordinary quadruped the base P–B occupies the whole length of the skull. Chimpanzee (*b*), Palaeoanthropian (*c*),* Homo sapiens *(*d*): The skull base becomes shorter as a result of the reduction of the dental arch; the mechanics of the facial bloc require equal shortening of P–C and C–B.*

of the La Ferrassie skull the size of the roots is already fairly close to that in races existing today. Facial development from the Palaeoanthropians to the modern human might thus be reflected in a steady reduction in the size of the roots of the front teeth, a process that goes back to the Australanthropians. The consequences of this regression are expressed in the three most important modifications that characterize the face of *Homo sapiens*: (1) The bone structure joining the front teeth to the supraorbital visor becomes progressively thinner and the orbital ridge tends to disappear, (2) the same phenomenon is mirrored in the mandible and the chin area undergoes thoroughgoing changes culminating in the development of the chin, and (3) the first molar becomes the base of the facial structure's most important pillar and the malar bones transfer the main lines of force to behind the supraorbital ridge, with the result that the cheekbones of the modern human are shaped very differently from those of Palaeoanthropians.

It is interesting to note that this process is not yet fully completed in certain primitive races such as Australian aborigines, whose orbital ridge is still fairly large. It is an even more interesting fact that the brain does not occupy all the space left available by facial evolution in many individuals of different races and that, as in the lower mammals, the frontal sinuses form a kind of valve between the container, mechanically conditioned by the teeth, and its contents, the brain. This offers yet more proof of the nonexistence of the supposed effects of cerebral expansion.

Thus we see that the Palaeoanthropians were something quite different from the nontypical and backward branch they have sometimes been thought to represent. Although it cannot be established that all forms were the direct ancestors of *Homo sapiens* (an idea that would be equally absurd in the case of *Homo sapiens* today, since some of the races that belong to our species will surely disappear without ever contributing toward a *"Homo postsapiens"* of the future), it should be obvious that by and large they must be seen as the root of the human races of today. This is still more evident when, in assigning each dated specimen its chronological place, we note the regular manner in which the Palaeoanthropians appear to have evolved toward the modern human.

The Spreading of the Cortical Fan

We have just traced the long development of human lineage, and have seen that our descent from the monkey may now be considered highly doubtful. A hypothetical two-legged ancestor has to be imagined, this side of the divide separating pithecomorphs from bipedal primates. Human characteristics cannot in fact be reduced to those of monkeys because the whole evolution from fishes to the gorilla shows that the factor of posture is fundamental: Monkeys—all monkeys—are characterized by mixed quadrupedal and seated posture and by the adaptation of their feet to the conditions of life resulting therefrom; anthropoids, on the other hand, have the fundamental characteristic of mixed bipedal and seated posture, to which their foot in turn is closely adapted.

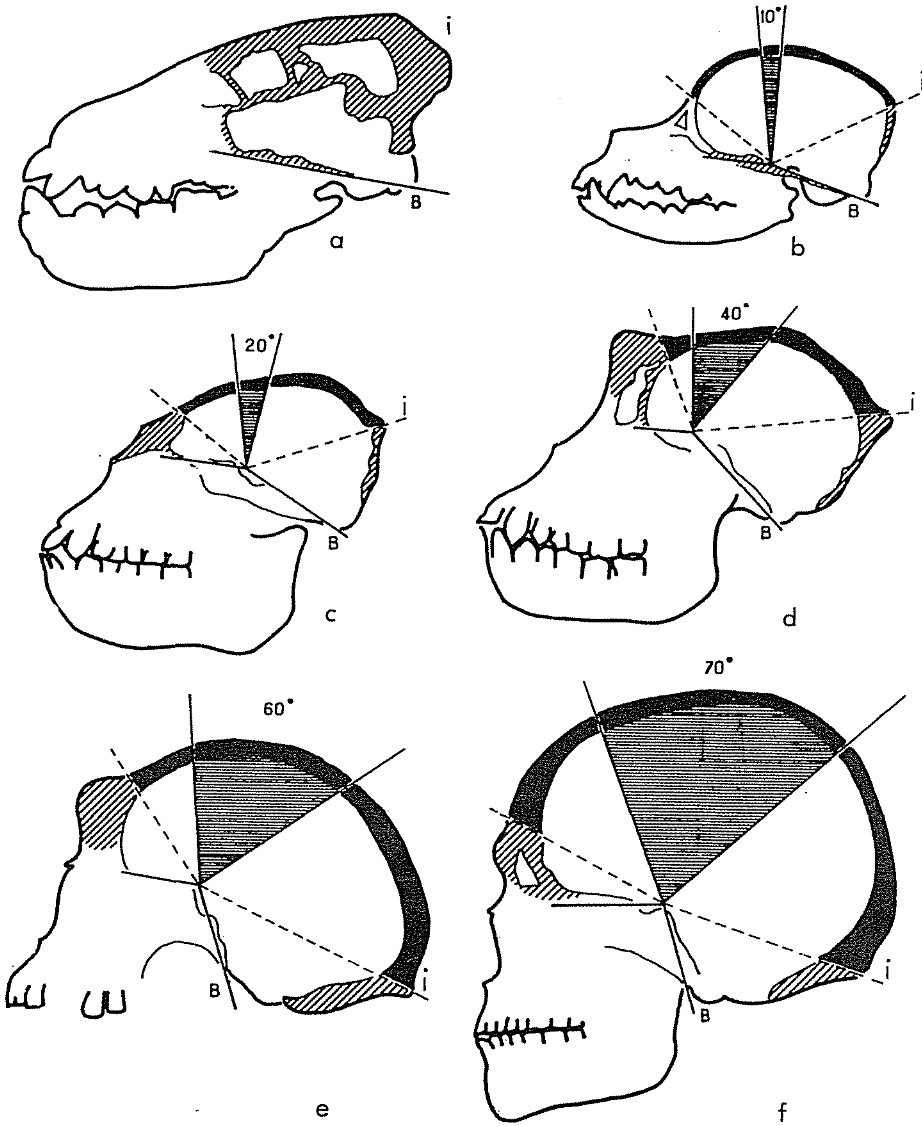
This difference in posture might be thought of secondary importance were it not the source of essential differences between the two lineages of beings whose hands are equipped with an opposable thumb. Anthropoids owe to their erect posture not only the fact of having their hands free during locomotion but also that of having a short face with small canines and a brain freed from the suspension stresses of the bony case. Following a series of successive liberations, freeing of the brain had already been achieved in the oldest remains, *Australopithecus,* who, as we have seen, would be more aptly named "Australanthropus." However far back we look for traces of ape-humans, we come up with nothing but humans. But how extraordinary are the oldest among them! From the feet to the base of the neck, there are no major differences between them and the peoples of today; the body is already completely human. It is surmounted by a head that is not the head of a monkey but one that has the face of a not-yet-humanized being. The facial bloc, very large and flat, without a forehead, is attached to a small, rounded cranial shell equipped with a bony ridge to which the muscles of a gigantic jaw are connected. The brain that activates this creature (so much more disconcerting than the banal *Anthropopithecus* dreamed up by Gabriel de Mortillet) is larger than a gorilla's, though tiny in comparison with ours, and weighs only half as much. Intelligence is not only a matter of brain volume but also of the organization of the brain's various parts: A very large monkey brain, equal in size to a human's, would still function only as a monkey's brain, more efficiently than a gorilla's because of the greater number of nerve cells it would contain but certainly not like a human's. *Australopithecus* did not have a monkey's brain but—and it may be even more difficult to come to terms with this fact—a human brain to match his extraordinary primitive face.

A detailed study of the brain of fossil man is not feasible, for obvious reasons, but casts of his cranial cavity give us a picture of the brain enveloped in the meninges, a picture clear enough to establish the proportions of the various parts and to visualize the main circumvolutions. Thus a paleontology of the brain is in some measure possible, and has indeed been practiced repeatedly during the past half-century.

Many works have been written that tell us about the workings of the brains of all kinds of animals, including ours. Our knowledge is as yet very imperfect, but we do possess extensive and consistent data on the brain's surface area, the easiest to explore by surgical or electrical means. This area includes much of the cerebral cortex, where the most important phenomena of responsiveness take place, and it is precisely a picture of the cerebral cortex that endocranial casts of fossils supply. Although there is no hope of establishing a complete picture of Australanthropian mental activity, with the help of casts and of modern physiology we can reconstitute a fairly consistent picture of what their cerebral apparatus could do.

We have already seen that the most important effect of the anthropoid skull's being suspended at the top of a completely erect vertebral column was to isolate the face mechanically from the back of the skull, a fact that resulted in lowering the iniac bloc and determined the orientation of the basilar clivus. The most obvious consequence of this is the pronounced "coiling" of the brain, which becomes L-shaped. This incurvation of the cerebral floor is geometrically conceivable only in conjunction with a considerable enlargement of the circumference of the convexity of the brain; in other words, the convexity opens up literally like a fan. This process does not take place in a uniform manner (figure 42): The forehead is constricted in its proportions by the facial bloc, of which it forms the base; the prefrontal ridge does not disappear until the emergence of *Homo sapiens.* The nape too is proportioned by mechanical suspension stresses so that the increase in circumference is greater in the center than at the extremities. The gain is equally great in the transversal direction; from *Australopithecus* onward, erect posture has as its corollary an enlargement of the area of the cranial convexity in the middle frontal-temporal-parietal region. This process is gradual, and its various stages can be traced from the monkey to each of the anthropoid forms. Up to the Palaeoanthropians the gain is constant and considerable, but from the Palaeoanthropians to *Homo sapiens* it appears to be very slight. Since the cranial convexity corresponds in humans to the area actually occupied by the brain, we can say with certainty that the clearest manifestation of cerebral development from the Australanthropians to the Palaeoanthropians is the increase in the surface area of the cortex in the central frontal and parietal regions.

This fact leads to some critical conclusions. First, it proves that although the evolution of the human body was completed very early, at the time of *Zinjanthropus* that of the brain was only in its beginnings. Second, it shows that if we are looking for differences between the minds of the great apes and the earliest humans, the most marked contrasts will be found in the properties of the middle cortex.



42. Spreading of the cortical fan. In the hyena (a) the convexity of the skull is completely barred. In the other examples, stresses are at their maximum in the frontal bloc and the inion bloc (I). In the Pomeranian (b) the freeing of the convexity of the skull (shown in black) is achieved exclusively through reduction of the face and loss of the frontal bar, and this entails loss of sinuses and of dental balance. The folding of the cerebral floor is very slight, as is the spreading of the temporal-parietal sector. In the Colobus monkey (c), the gorilla (d), the Palaeoanthropian (e), and Homo sapiens *(f) reduction of the base and progressive folding of the floor have caused the middle sector, which corresponds to the voluntary motor function cortex and to areas of association, to open out more and more.*

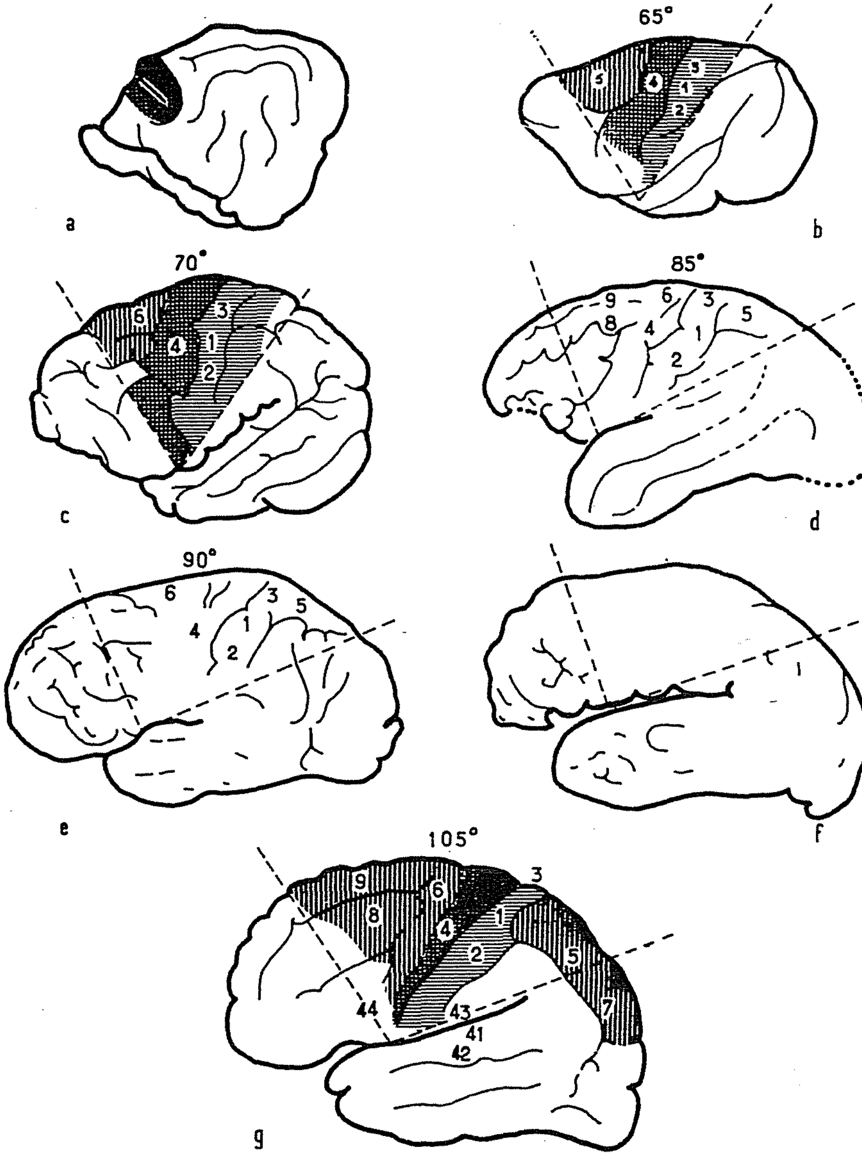
The Middle Cortex

Many works have been written about the middle cortex of the brain (figure 43) of animals and humans, and in particular about the cortical areas which, in the higher mammals and in humans, are situated to either side of the fissure of Rolando. In front of this fissure are located the pyramidal fibers of projection (area 4), connected with the motor function of different parts of the body, and behind it (areas 1, 2, and 3) lie fibers of sensory afference corresponding to the same parts. With the help of electrical exploration methods and neurosurgery it has been been possible to determine with precision to what part of the body each group of cells relates—forming, as it were, a neuromotor picture of the physical individual. This picture is an upside-down one, the fibers that concern the motor function of the head and forelimb being situated near the cranial floor and those related to the feet near the convexity.

It is very important for our purpose to try to trace the development of the neuromotor system from the quadrupeds onward, an exercise that will bring out some essential points concerning the relationship between the animal world and humankind.

From the simplest system—the invertebrates, in whom the sensorimotor apparatus is limited to two chains of ganglions that animate the segments of the body and an anterior nerve junction where the earliest responsiveness apparatus is organized—the nervous system becomes progressively richer, both through an increase in the number of connections with the body and through a growing number of possibilities of coordinating the action of these multiple nerve controls from the site of the brain. As in the case of an electric or electronic device, this results in a greater or lesser number of connecting wires (neurons) terminating in an integration device whose possibilities are directly proportional to the number of connections. In humans the number of within-brain and brain-body connections is around 14 *billion.*

The cerebral edifice began modestly enough with the lower invertebrates, in which each segment of the body lives separately and has only the essential minimum of connections with the rest of the organism. This fundamental independence is still considerable in worms. It subsists in vertebrates (a segment of an eel will jump inside the frying pan, a headless duck will go on running for a few yards), but side by side with it there will be connections to the cerebral system for all processes directly or remotely related to activities of responsiveness. The first nervous systems of vertebrates are still very simple and, as we have seen, occupy but little space inside the skull. Their refinement (in the sense of an increasingly differentiated and con-



43. Brain of a cat (a), *a macaque monkey* (b), *a chimpanzee* (c), Australanthropus (d), Sinanthropus (e), *Neanderthal man* (f), Homo sapiens (g). *Areas 1, 2, 3: somatomotor region; area 4: voluntary motor function; areas 5, 6, 7, 8, 9: extrapyramidal motor region; areas 41, 42, 43: auditive region; area 44: verbal articulation region. Intracranial casts are not very accurate in terms of detail, but in terms of proportions it can be categorically stated that the fossil anthropoids are human.*

scious use of organs) was the result of integrating devices being added to the existing system to synthesize sensations and distribute images and responses. From animal to humans the development proceeded roughly as though one brain were added on top of another, each new formation bringing about the increasingly subtle cohesion of all previous ones, which continued to perform their functions. The most recent formation, which began to gain importance only with the mammals, was the neocortex, a device for motor and sensory integration that eventually developed into the instrument of human intelligence. The functional structure of the cortex or neopallium of vertebrates has not yet been defined in detail, and there would be little point here in going back to its origins. If our purpose is to show the continuity between the neurological data and what has been said concerning the mechanical development of the cranial apparatus of vertebrates, it will suffice if we begin with already developed quadrupedal mammals.

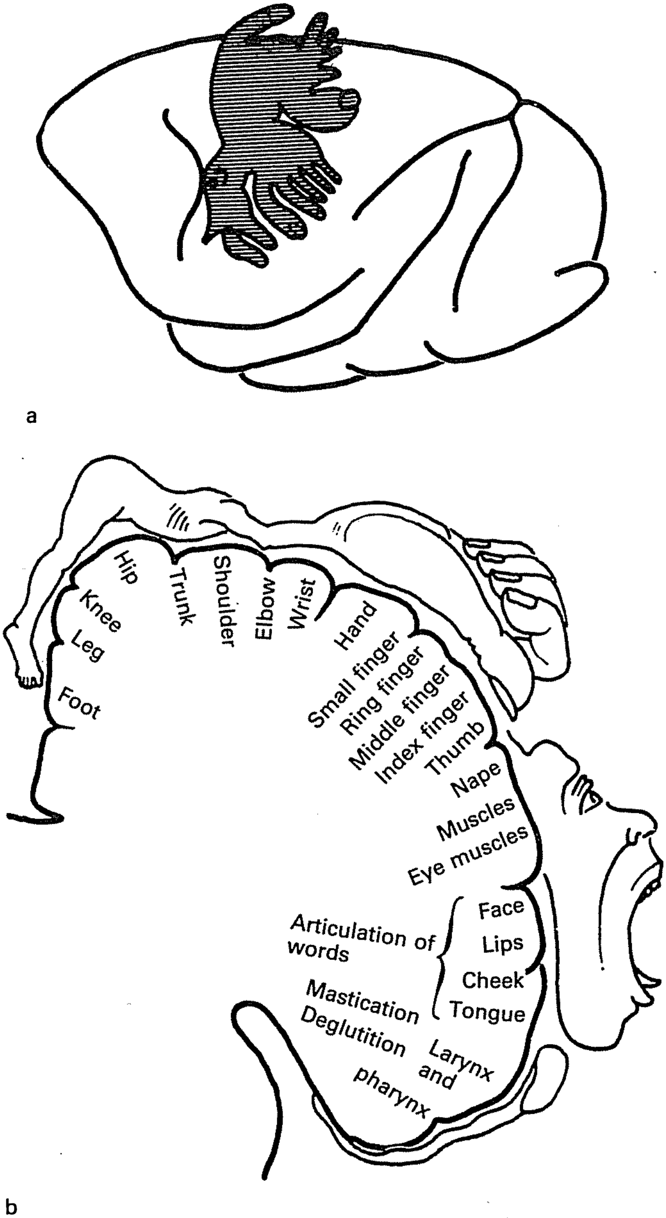
In animals such as the horse, the pig, or the goat—walking quadrupeds whose anterior field is essentially facial—the sensorimotor cortex is individualized rather clearly at the end of the fissure of Rolando, the participation of the forelimb being practically nil in the horse, very slight in the pig, and more developed in the goat. Exploration of the cortex in all three animals shows a well-differentiated representation of the muzzle in the sensorimotor cortex. The forelimb, on the other hand, is barely individualized by just a few points corresponding to the anterior surface of the wrist. These animals' fine senses, their "intelligent" motor function, is therefore confined to the area surrounding the buccal orifice, and their manual technicity to some slight possibilities of holding something down or pushing something away with the forefoot.

In carnivores, where manual participation is already pronounced, the sensorimotor areas of the cortex are richer in fibers and the representation of different parts of the body is more subtle. The rear part remains very sketchily represented, coordination of movements in that area taking place at levels that do not involve consciousness, but the face and the two forelimbs are clearly distinct and quite subtly organized. The cat in particular shows a high degree of separation, which is reflected in the use it makes of its front paw in a large number of operations. This demonstrates the truth of a general fact that I have already mentioned more than once: Unlike the walkers, all the graspers—even those a long way from the human end point of the evolutionary process—possess the basic possibilities for technicity. In carnivores the technical areas of the cortex are restricted by a very rigid mechanical apparatus. The cortical "fan" is hardly opened out at all, but what there is may suffice to make us realize how far down the scale of the animal world the instrument of human technicity was formed.

In cynomorph monkeys such as the macaque, the cortical fan is well spread out and the primary sensorimotor triangle (areas 1 to 4) has been enriched with an extra-pyramidal premotor zone (area 6) which develops an additional degree of motor integration. The picture of the corporeal instrument has become extremely detailed. All parts of the body are distinctly represented in the cortex, in varying proportions that are revealing of the motor organization of primates. Roughly two-thirds of the cortical surface are occupied by cells of the face, the hand, and the foot. Almost a quarter of the total surface is taken up entirely by neurons that control the tongue, the larynx, the lips, the thumb, and the big toe (figure 44). With the chimpanzee and the gorilla the situation is practically the same in kind but more developed in degree. Because the number of cells is greater, each finger is represented separately, whereas in cynomorphs the four fingers of the palm are integrated with each other. The situation of the human, so far as the principal motor and premotor zones are concerned, is not fundamentally different from that of anthropoid apes. At each stage, evolution constructs a new brain on top of the preceding one. The higher quadrupeds' motor strip is succeeded by the premotor triangle of the monkeys, and this in turn is overtaken by new formations.

At the simian stage the situation is already quite remarkable. Anatomical correlation has resulted simultaneously in the achievement of mixed posture (seated, with quadrupedal locomotion) and the development of the middle part of the cranial convexity. Unlike the brain of certain flesh-eating animals, that of primates has reached the limits of its possible development and adheres closely to the cranial contours imposed by mechanical requirements. Although this has been at least implicitly supposed in the past, the expansive force of the brain cannot have acted as the motive force in the evolution of the skull. The number of nerve cells cannot increase before the edifice has been enlarged. Even if we regard cerebral expansion and spatial improvement of the skull as a single phenomenon, we have to acknowledge that the brain followed the general movement but did not generate it.

Monkeys therefore have the brain that corresponds to the state of mechanical freeing of their cranial convexity, that is, a brain whose sensorimotor cortex is remarkably wide and allows a considerable degree of control, both separate and coordinated, of the facial and manual apparatus. No one who has studied the behavior of the higher apes can seriously doubt that the reason why they cannot exercise techniques in the human sense of the term is the equipment of their motor and pre-



44. Cortical picture of voluntary motor function in (a) a macaque monkey (after Woolsey) and (b) a human (after Penfield and Rasmussen). In the monkey note the importance of the image of the hand and foot, and especially of the thumb, as compared to the face. In the human, note the reduction of the foot and the tremendous importance of the hand and the organs of speech (lower part of the face, tongue, larynx). The macaque's brain is shown in profile, the human's in cross section.

motor cortex. Yet, impressive as the experiments in monkey behavior have been, there is an unbridgeable gap between the action of a monkey using two bamboo rods to climb on top of a box and grab a banana and the toolmaking action of *Zinjanthropus*. The fact that beings as close to us as the chimpanzee should exhibit something in the nature of a dawning elementary technicity is in no way surprising. It is hardly more extraordinary than the traces of the rhinoceros that can be found in the tapir, of the beaver in the squirrel, or of the badger in the bear. But the monkey did not turn into the human any more than the rhinoceros turned into the tapir.[7]

The Hominid Brain

Studies of endocranial casts of *Australopithecus, Pithecanthropus,* Neanderthal man, and modern man reveal differences in the proportions of various parts. The differences principally involve the frontal lobes. Apart from differences in volume and in surface area, practically no variations other than such as might be found between the brains of different present-day humans are to be seen in the middle and occipital parts of the brain. The increase in the brain's total weight (which more than doubled from *Australopithecus* to *Homo sapiens*) and the greater complexity of the convolutions that add to the surface area of the cortex do certainly imply a very different level of intellectual development at both ends of the evolutionary series, but they do not *a priori* imply anything other than humanity. In other words, we find from the outset that the brain of *Zinjanthropus* is shaped like the brain of a human, not of a monkey, but that it is small and rather thickly folded, with proportionally very small frontal lobes. Having recognized that the difference is one of degree rather than of structure, we can interpret such facts as we know about the life of the forms that preceded *Homo sapiens* within a human perspective. We should not, however, imagine that our difficulties will be over once the monkey has been put firmly back in its place and no longer appears as the starting point of a line on which the precise position of the frontier of humanity is yet to be determined. As we say farewell to the "missing link," the collection of men that emerges from the available fossil records must raise doubts as to whether a single definition of "human being" is possible.

In chapter 1 we defined fossil "men" as possessing erect posture, a short face, a free hand, and tools. The problem we need to resolve now is that of the organization of the cerebral apparatus which distinguishes the human from the monkey in the exercise of techniques. The discovery of *Zinjanthropus* has taught us that technicity is present even in the most rudimentary of human forms. Detailed exploration of the cerebral cortex of the modern human provides the elements for several hypotheses on this score.

Primitive Motor Function

Like the brain of the higher mammals, the human brain has a primary motor zone (area 4) above the ascending frontal convolutions along the fissure of Rolando, a zone inside which groups of neurons controlling the face, the fingers of the hand, the upper limbs, the trunk, and the lower limbs can be separately identified from the base to the apex (figures 43 and 44). As in carnivores or monkeys this zone offers an upside-down picture of the body mechanism of which it is the control panel. The number of neurons allocated to each part of the body is proportional to the complexity of the operations it performs. In modern humans roughly 80 percent of area 4 is assigned to controlling the head and the upper limbs, which means that eight-tenths of the primary motor apparatus are required to control the two poles of the anterior field. The tongue, lips, larynx, pharynx, and fingers alone account for almost half of area 4.

While the quantitative differences between this and a monkey's brain are enormous, the relative proportions between the areas are almost the same. In monkeys the facial organs and the hand account for one-half of the motor apparatus. The only significant difference concerns the big toe, a fact that reflects the difference between the method of locomotion of tree-dwelling primates and bipeds living on land. The neural representation of the face and the hand is thus the same in human and monkey; in other words, their respective brains reflect an activity shared equally between the facial organs and the forelimb. In the monkey this sharing involves, on the one hand, coordinated actions of food capture and preparation, attack and defense, grooming and locomotion (hand), and mastication and deglutition (face), plus a few hand gestures and some facial mimicry. In the modern human, as we know, the respective shares are rather different: The hand predominates in coordinated actions of grasping and preparing food, as well of attack and defense, but is no longer involved in locomotion. Above all, the hand serves for making things, whereas the face is the instrument of phonation organization as language.

These facts lead on to a number of general considerations. In terms of the pyramidal organization of motor function, the solution for the anterior field is the same in monkey and human. But it is not applied in the same way, and we have yet to understand why humans use their hands for making and faces for speaking. More important, all the evidence suggests that the formula for the pyramidal cortex was the same in Australanthropians, namely that in them (as in the macaque monkey or in ourselves) hand and face played roles of roughly equal importance and were mutually coordinated.

Another interesting fact is the contiguity of the respective zones of the face and the hand in area 4 and their common topographical position. Hand actions are closely coordinated with those of the anterior organs of the face. In the monkey this link is primarily related to feeding and the same is, to a lesser extent, true of the human, but in the latter case coordination between the face and the hand is equally pronounced in the exercise of speech. This coordination, which is reflected in the use of gesture as a commentary to speech, reappears in writing as the transcription of vocally emitted sounds.

Simians and anthropoids thus possess the same primary motor cortex in which all parts of the body are clearly represented, representation of the face and the hand being dominant. The same representation, albeit less clearly marked, is found in the cat and the dog, but there it is the ultimate integrative device of their brain structure, which in the monkey is only the penultimate stage. If we destroy the pyramidal motor area in a cat or dog by surgical means, we find that the operating sequences instilled by training disappear; the animal loses what it has learned. In the monkey, as we have seen, a premotor prepyramidal area (area 6), acquired through early development of the cortical fan, has been added to the front of the primary motor area: It is here, in area 6, that integration takes place. The role of the pyramidal area is no longer exclusive. The process is the same as with an electronic apparatus where, proceeding on the basis of an earlier electronic device, we can increase the number of functions by adding on further devices. We see how accurate the comparison is when, having destroyed a monkey's pyramidal cortex, we find that its learning memory has survived. The animal has retained what it has learned and is capable of adding to it. However, the destruction of the premotor cortex (area 6), which constitutes the final stage, does entail loss of what has been learned and serious difficulty in acquiring new operating sequences. Thus the spreading of the cortical fan certainly signifies an improvement of the neuronal apparatus, for a monkey's capacity for integration is richer than a cat's or a dog's.

Human Motor Function

The irremediable lack of direct observations of fossil anthropoid brains obliges us to pursue the argument in terms of the modern human. It will be seen later on that a verification can be carried out with the help of products of fossil man's industry. Furthermore, since the organic unity of anthropoids has gradually come to be an accepted fact, facts observed in the modern human must be considered applicable to reconstructions of the past. We are not trying to connect two different zoological groups by looking for transitional stages but rather to compare different chronological states of the same structure within the same zoological group, the anthropoids. In preparation for what will be discussed in chapter 4, let us add that we are concerned strictly with the middle area of the cortex, for the moment excluding the frontal parts. The point at issue is therefore to demonstrate that technicity (to the exclusion of other forms of intelligence, which will be considered later) was an early anthropoid characteristic and that its character remained the same throughout the family as a whole.

The motor part of the cortical apparatus of modern man (figure 43) consists of the primary motor area (area 4) in front of which, as in monkeys, lies the premotor area (area 6). Still further in front is an additional area (area 8), whose structure is midway between that of the premotor area and that of the frontal lobes, which have no motor neurons. The fan has thus been spread to expose a new segment. Since the quadrupeds, the integrative motor apparatus, which now comprises three stages, has steadily expanded toward the front: Area 8 orients motor integration toward the nonmotor frontal areas, which are very small in monkeys and whose development was still far from complete in fossil man.

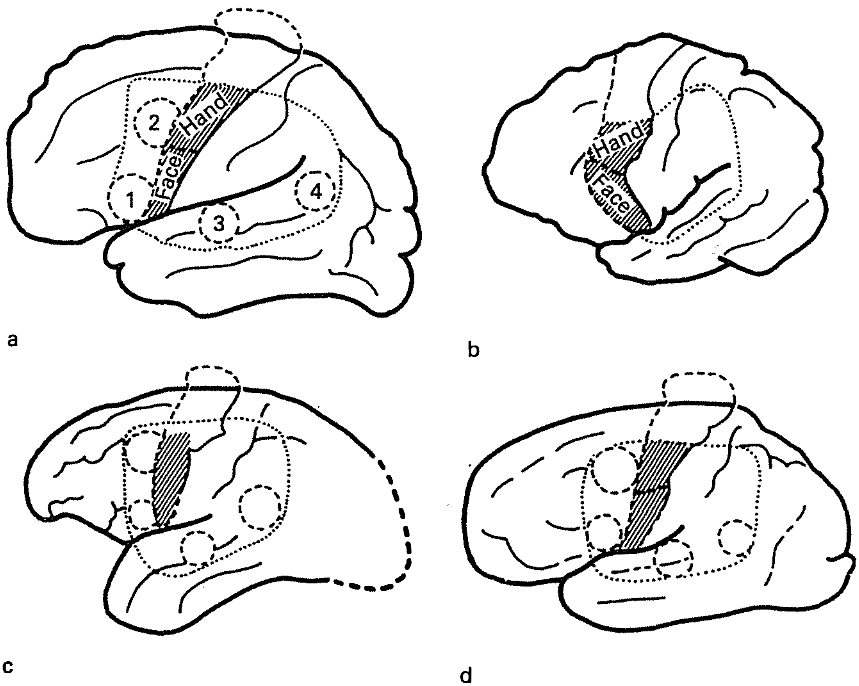
Around the motor "fan" are grouped various devices that are afferent to sensory impressions and ensure that such impressions are integrated in the neuromotor apparatus. Visual impressions have their own zone (areas 17 to 19) in the occipital lobes; somatic impressions (areas 1, 2, and 3) occupy a strip parallel to area 4 at the rear edge of the fissure of Rolando, its division corresponding to those of area 4. The temporal region (areas 41 to 44), which is the center of the "coiling" movement of the anthropoid brain and where for that reason the most important changes have occurred, is of particular interest in that since Broca, its study has been related to the problem of language.

The Language of Anthropoids

The problem of language will be discussed in several of the later chapters; here we will endeavor to obtain a certain amount of information—which we shall later check against the facts—from data supplied by the anatomy of the brain, incomplete though these data are.

The cortex of the junction between the frontal, parietal, and temporal regions is composed of the lower parts of the motor and premotor areas (areas 4 and 6)—of those motor areas that concern the face and the hand (figure 45). In the forward part the premotor area adjoins two zones of association. One zone lies at the foot of the second frontal convolution (bottom of area 9) and relates to the motor centers of the hand, while the other is situated at the foot of the third frontal convolution (area 44) and comes into contact with the motor centers of the face.

At the back the motor strip controlling the face and hand is contiguous with the corresponding parts of the somatic areas (1 and 2). Lower down and toward the back it touches upon the areas of auditive association (41 and 42), and still further back it is indirectly connected with the area of visual association (19). Since Broca's discovery in 1861 that lesions of the lower part of the third frontal convolution deter-



45. Speech in anthropoids. The area of voluntary motor function is shaded; the dots indicate P. Marie's quadrilateral area of aphasic lesions—anarthria (1), agraphia (2), word deafness (3), word blindness (4)—in, respectively, Homo sapiens *(a), a chimpanzee (b),* Australanthropus *(c), and* Sinanthropus *(d). It will be seen that the monkey's brain has no sectors corresponding to areas of integration except for auditive and visual recognition. In* Australanthropus *and the Archanthropian, on the other hand, the presence of centers of speech integration is topographically possible.*

mine loss of the power of speech, area 44 has been known as the speech center. Cortical topography has made great strides in the past hundred years, and the problem of speech is now more broadly based than could be imagined by a neurological science still impregnated with phrenological ideas about the loci of the brain.[8]

The apparatus we have described forms the cortical framework for the modern human's speech. Neurological experiments have demonstrated that the zones of association that surround the motor cortex of the face and hand are jointly involved in producing phonetic or graphic symbols. As Broca discovered, disorders of area 44, which adjoins the pyramidal cortex of the face, cause *aphasia* or inability to form coherent phonetic symbols, while lesions of the auditive areas (41 and 42) cause *word deafness,* or inability to identify the words one hears. The two zones that frame the motor cells of the face—one being transitional to the prefrontal regions and the other to the auditory system—are therefore directly involved in vocal language. But it is perhaps more important for our purpose to identify the nature of the speech disorders that involve the function of writing: Lesions of the lower part of the second frontal convolution, which adjoins the motor areas of the hand, determine *agraphia,* or inability to write, while lesions of the preoccipital visual area (19) cause *alexia,* or inability to read. It goes without saying that these deficiencies are not concerned with the ability to see and hear or to emit sounds but, rather, with lack of the intellectual capacity to express or comprehend vocal or graphic symbols.

These elements already offer a rudimentary paleontological view of language. First of all, a distinction has to be drawn between the physical possibility of organizing expressive sounds or gestures and the intellectual possibility of inventing expressive symbols transformable into sounds or gestures. Symbols in turn must be divided into those specifically linked with operations involving the manual field and those not involving any manual operations.

If we consider the cortex of the higher apes, we see that areas 41 to 44 are barely there at all. Instead of encompassing the cortical series 4, 6, 8, and 9 to 44, the neuronal system practically stops at stage 8; this means that the equipment for articulation and gesticulation is subhuman. The ability to hear symbols is also very largely lacking. The middle cortex of the great apes, closely confined as it is between the frontal and iniac blocs, is physically incapable of constituting a language.

With the disappearance of the iniac bar, however, the cortical fan can open out wide, creating a topographical situation of benefit to the middle cortex as a whole. Until the emergence of *Homo sapiens* the expansion of the prefrontal region remains very limited, but the presence of verbal and gestural association areas is perfectly conceivable from the Australanthropians onward. Bipedal posture and a free hand automatically imply a brain equipped for speech and, consequently, a brain box with a good deal of free space beneath its central convexity. We must, I believe, infer that the physical potential for organizing sounds and gestures was already present in the first known anthropoid. The question of the intellectual level of the language of *Zinjanthropus* is one we shall revert to in another context later on, but the virtual existence of language in the earliest hominids cannot be doubted.

Everything thus suggests that the opening out of the cortical fan in the higher mammals occurred in four stages, each of which corresponded to a stage in postural development. In the earliest stage we find the first traces of a fine organization of pyramidal motor cells, almost all connected with the motor function of the anterior facial organs, at the edge of the central sulcus in walking quadrupeds. The second stage is represented by grasping quadrupeds, in which the potential offered by seated posture and temporary freeing of the hand is not accompanied by any modification of the cranial suspensory apparatus. The motor cortical strip is already present in an organized form and the hand is well individualized. The third stage is that of monkeys, whose achievement of seated posture did entail a modified cranial suspension, with the addition of a premotor strip to the pyramidal strip and highly differentiated manual operations. The fourth stage is that of the acquisition of bipedalism accompanied by profound changes in cranial suspension and by the freeing of the hand; the cortical fan is fully spread out and connects with centers afferent to the areas involving language.

Zinjanthropus

Perhaps the most important development for the science of fossil man was Leakey's find on July 17, 1959, in the Olduvai Gorge in Tanganyika, of *Zinjanthropus boisei* accompanied by very primitive but unmistakably human-made tools. This event came several years after the finding of an Australopithecine pelvis in South Africa. For two years it had been known that Australopithecus had walked upright, and several scholars had put forward the view that his possession of tools was more than probable. Leakey's find put an end to the myth of the ape-human, at any rate in scientific circles. The world was obliged to accept the implications of the hitherto unforeseen fact that the development of the human body had been completed by the end of the Tertiary period of the Cenozoic era, even if the development of the human mind had barely begun.

Zinjanthropus (and other Australopithecinae) made tools: For the first time in the zoological series, this fact raised the question whether a species characteristic derived from a sphere other than anatomical biology might have validity. The emergence of tools as a species characteristic marks the frontier between animal and human, initiating a long transitional period during which sociology slowly took over from zoology. At the Zinjanthropian stage tools appear simply as an anatomical consequence, the only solution possible for a being whose hands and teeth had become completely useless as weapons and whose brain was so organized as to permit manual operations of a complex nature.

Raymond A. Dart, whose discovery of the first *Australopithecus* in South Africa in 1929 was followed by many other finds of these earliest known anthropians, had studied the animal remains found together with them. He had reached the conclusion that *Australopithecus* was, unlike the ape, a hunter whose prey, in the south of the African continent, seems to have consisted of small- or medium-sized antelopes, quite frequently of wild pigs and baboons, and occasionally of animals as large as the zebra, the rhinoceros, and the hippopotamus and as dangerous as the panther. Before the discovery of stone tools in strata containing fossil remains, Dart thought that the Australopithecinae had used tools made of bone and particularly of the humerus of antelopes, as hand axes. He invented the concept of an "osteodontokeratic" industry by selecting those bone fragments that in his view were the most characteristic. Today it seems fairly clear that this industry is for the most part fortuitous in nature, but the possibility that large bones were used as hand axes, and especially that the horns of animals were used as crushing tools, should certainly not be dismissed.

The *Zinjanthropus* fossil of Olduvai was found surrounded by chipped pebbles. These form part of an industry that had long been known in Africa under the name of "pebble culture," found in horizons of the earliest Quaternary and very late Tertiary periods of the Cenozoic era from the north to the south of Africa, and that had already for some years been suspected of being the work of the Australanthropians.

Flaked Pebbles

The products of the African pebble industry correspond to what may be imagined as being the first form distinct from the naturally occurring cobble. The earliest products of human industry are not easy to recognize. Prehistorians have been grappling with this task since the 1860s. Tools are readily recognizable as soon as they acquire a permanent form through secondary processing, but to distinguish between a knapped stone and an unprocessed fragment is difficult. Clastic rocks such as flint and quartzite, when subjected to a sharp impact, produce flakes with conchoidal partings, known as the "percussion bulb." To produce flakes of a desired shape, the impact must be directed and applied with some force, which in most cases presupposes a conscious act, but after the hundreds of millions of impacts exerted on pebbles by undertow or falling water, some will look human-made through pure chance. We may therefore say that although the presence of a "percussion bulb" strongly suggests human intervention, the possibility remains that some of the flakes that have been found were fashioned by nature. Thus students of prehistory were seriously exercised toward the end of the nineteenth century by the problem of early and middle Tertiary "eoliths."

Unless the samples have been deliberately or unconsciously selected, a collection of eoliths has this particularly striking characteristic that no morphological consistency is perceptible, the forms being distributed in a completely random manner. The only morphological constants that can be observed are of a purely mechanical order—a matter of accidental thinness of the edge of a kidney stone, or of indiscriminately projecting parts, or again, in the case of very long kidney stones, of fractures caused by bending. If the earliest human industry had been such, the problem could never have been cracked by scientific study of prehistory, and this earliest evidence would have no value.

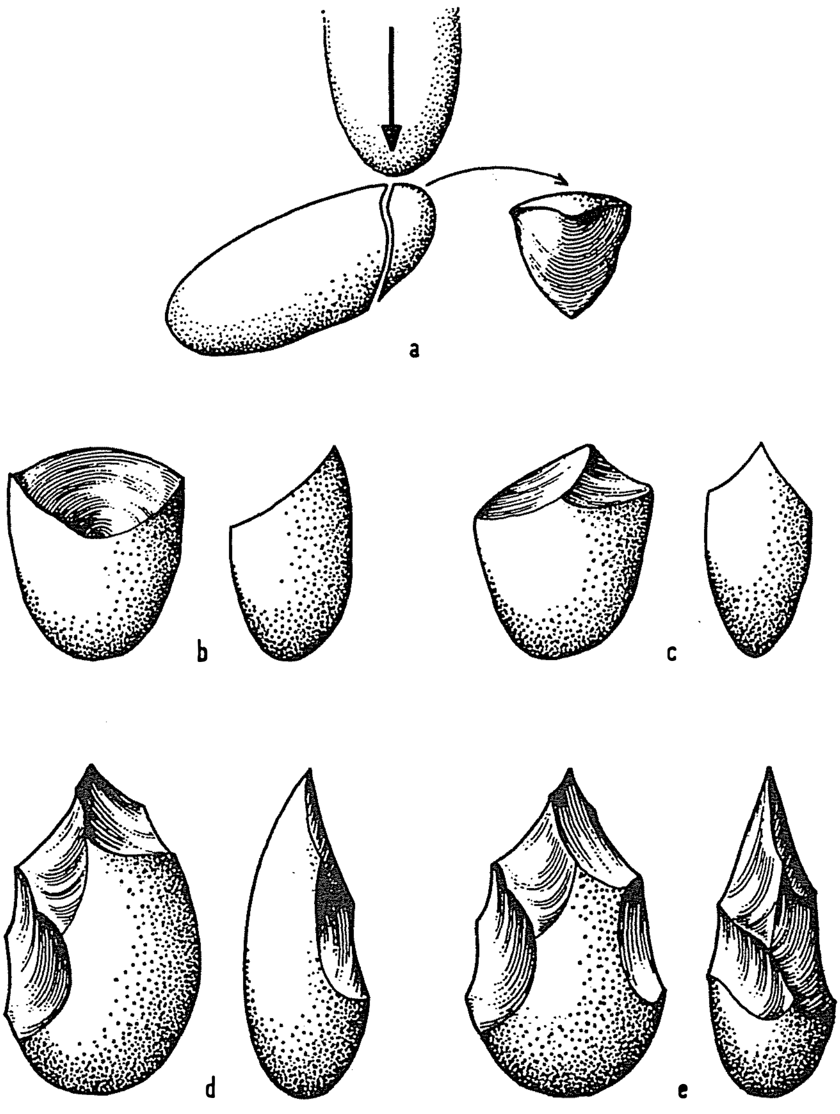
But the theory of random impacts could have been thought up only by a scholar who imagined primitive man as Gabriel de Mortillet imagined him—a kind of half-monkey entirely lacking in experience, playfully bidding for the title of First Man by banging on stones with one of his newly freed hands while shielding his eyes with the other. Restored to its proper biological and paleontological context, the problem looks very different. At the close of the last chapter we arrived at the concept of tools as being a "secretion" of the anthropoid's body and brain. If that is so, then it is logical that the standards of natural organs should be applied to such artificial organs: They must exhibit constantly recurring forms, their nature must be fixed. The same rule in fact applies to all products of human industry in historic times: There exists a stereotype of the knife, the ax, the plough, or the aircraft that is not only the product of a coherent intelligence but is also integrated in a substance and a function (see chapter 7). It may be objected that in the case of the stone industries, many products have an irregular form because of random flaking. But prehistorians have avoided this error, and each period is designated by its stereotype—biface, scraper, or burin. We can, indeed we must, think of the earliest Anthropians as having an intelligence inferior to our own, but we have no right to imagine their intelligence to have been biologically incoherent. Either the earliest human-made tools are indistinguishable from unprocessed stones or their forms are constantly recurring ones.

The Australanthropian Stereotype

That the flaked pebbles of the pebble culture (figure 46) do in fact correspond to a stereotype is attested by a million objects. Their making presupposes two pebbles, of which one serves as a hammer while the other receives the blows. The blow is applied to one of the edges in a direction perpendicular to the surface, and breaks off a flake that leaves a sharp edge. Two or three more blows will make the edge sinuous and extend its length. Applied to only one surface of the pebble, the operation results in a "chopper"; applied to both surfaces, in what is known as a "chopping tool." Without dwelling on the possibly arbitrary implications of these terms as regards the tool's purpose, we must note that the operation involves only one kind of action, the simplest, that of striking the edge of the pebble at an angle of 90 degrees. *One* action producing *one* cutting edge represents the point beyond which identification becomes impossible, which is why I believe it will be difficult to go back much further than the Australanthropians in seeking the origins of human industry. I reach this conclusion with some regret, for manual operations certainly did not begin at the Australanthropian stage.

The choppers discovered together with *Zinjanthropus* and in innumerable similar sites scattered across Africa tell us hat Australanthropians made chopping edges by means of a single movement, that of simple percussion, the same gesture as would serve to split a bone, crack a nut, or bludgeon an animal. In fact the Australanthropians found at Olduvai and elsewhere were surrounded by hundreds of broken bones. Thus the first anthropoids' technicity was of an extremely simple kind, more or less in line with what we know about their brain. Yet it was certainly human, and it seems consistent with the organism of the being whom it complemented. The state it implies is one of technical consciousness to which, however, we must not apply our own yardstick. It is undoubtedly less of a risk to see human technicity as a simple zoological fact than it would be to credit *Zinjanthropus* with a system of creative thought. The countless millennia during which his industry remained unchanged—conditioned, as it were, by the shape of his skull—disproves the latter hypothesis.

Study of the earliest anthropoids may well lead to a complete revision of our views concerning human nature. In the first chapter of this book we demonstrated



46. Industry in the first stage. The operating sequence is confined to a single action (a) used to produce a tool that develops from the chopper (b) to the rudimentary biface (e) through the addition of points of impact and the fashioning of a tip (c, d).

that the image of our ancestor is an artificial one born in a context of ideological struggle in the seventeenth century and devoid of any foundation in paleontology. In the nineteenth century and the first half of the twentieth, this image was continuously projected upon each newly discovered fossil in a systematic endeavor to accentuate the contrast between the ape-human (Pithecanthropus) and *Homo sapiens,* "knowing human." This attitude, incidentally, was shared by rationalists and believers alike. It remains essentially foreign to a human solution of the problem of our origin, its object being to situate the "frontier of humanity," the "cerebral Rubicon," the "search for Adam," somewhere along a line of progressively less and less bestial creatures. The point at issue is, however, altogether different: Instead of a "superbestiality" ending supposedly, no one quite knows how, in the acquisition of the human "modicum of intelligence," the Australanthropian brings us face to face with a humanity that is already achieved but unrecognizable and probably well short of the "modicum of intelligence" we would grant to the monkey in order to be able to regard it as our ancestor.

The Archanthropians

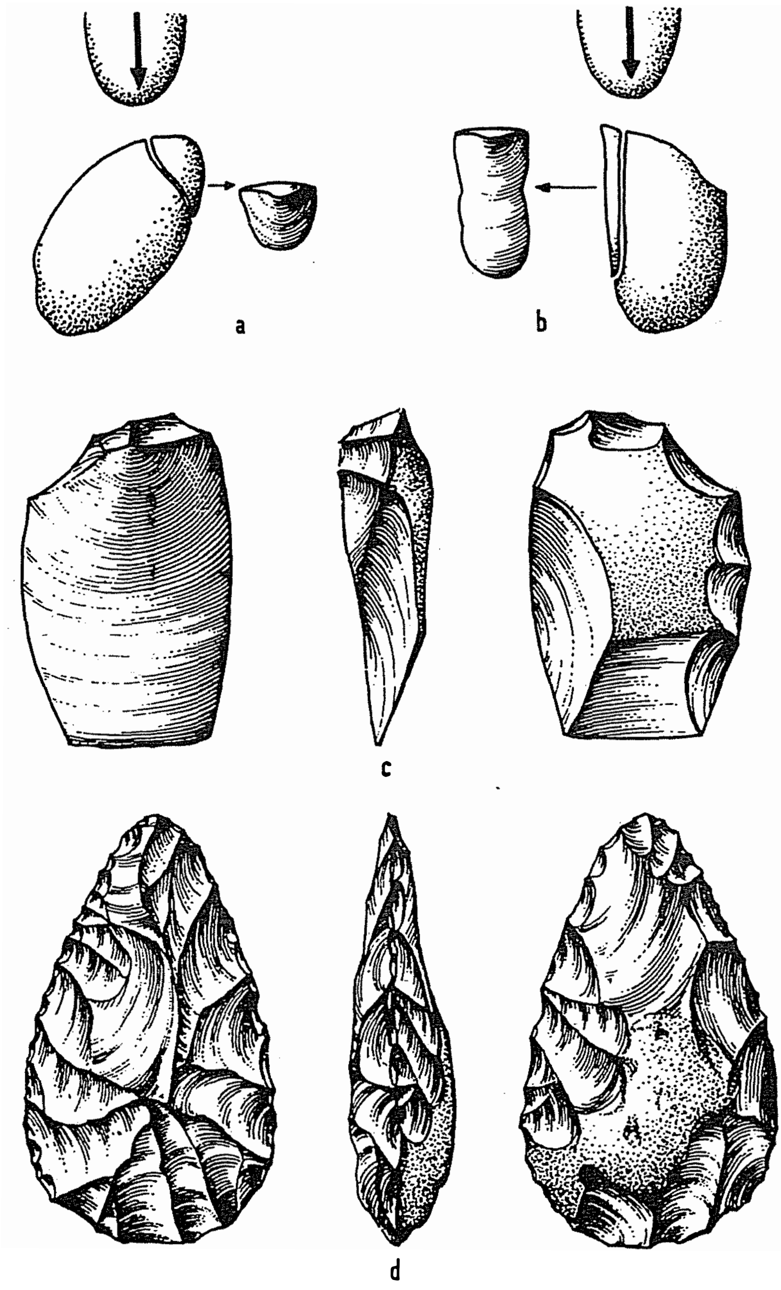
In chapter 2 we saw that allowing for some serious gaps, we know enough about the Archanthropians to be able to visualize their physical appearance with some accuracy. Their geographical distribution was very extensive. Traces have been found, in chronological order, in Java (*Pithecanthropus*), Europe (Mauer man), China (*Sinanthropus*), North Africa (*Atlanthropus*), and probably in East Africa (*Africanthropus*). Despite some anatomical differences all these fossils have so many characteristics in common that they can be grouped under the general heading "Archanthropians." So far as one can judge, their distribution in time is fairly consistent. Broadly speaking, they lived during the immensely long early Quaternary period of the Cenozoic era, the Australanthropians in its Villafranchian part, and the Palaeoanthropians in the middle Quaternary. Their physical appearance was human in terms of stature and posture, but their skull, as we have seen, still looked very different from ours. Their brain, although markedly more developed than the Australanthropians', was still tightly barred in front by the orbital bloc. Its volume (1,000 cubic centimeters) was a little less than twice the Australanthropians' and roughly two-thirds of the modern human's. Evidence of their intellectual attainments is unfortunately very slight. Only Sinanthropians were discovered in their habitat, the Atlanthropians being found near a spring, Mauer man in alluvial deposits, and *Africanthropus* broken into small fragments in the sedimentary deposits of a lake. The

Asian Archanthropians' industry has not yet been fully investigated. The thousands of tools found with Sinanthropians were fashioned from quartzy rock whose poor quality makes it quite impossible to form an opinion of the makers' manufacturing skills.

The tools of Pithecanthropians are likewise little known because the sites where bone remains have been found are not habitats. A part of the industry discovered in Java can be attributed to them only by comparative methods. Those of Atlanthropians, on the other hand, are well known and belong to a still somewhat primitive stage of the Acheulian. No records of Maueranthropian or Africanthropian industry have been found as yet. Thus the only solid point of reference is supplied by the Atlanthropians of Terrifine, whose contribution, in a certain sense, is as revolutionary as that of the Australopithecinae. Until C. Arambourg's discovery of Atlanthropian tools and mandibles in 1954, it was still possible to entertain illusions about the Archanthropians' technical level: Sinanthropian tools were too poor in quality to constitute a challenge to any hypothesis (although Abbé Breuil did point out that they represent a higher technical level than their appearance suggested), and none of the other fossils found was obviously related to any industry at all. Prehistorians and paleontologists were extremely reluctant to admit, as unchallengeable factual evidence eventually forced them to do, that it was to the Archanthropians that most of the industries of the Lower Paleolithic and, in particular, of the Acheulian had to be ascribed. The evidence of the Atlanthropians who made hand axes and bifaces is enough to make us accept the view that the anthropological nature of their contemporaries in other parts of Africa and on the Old Continent was the same as theirs. But even by itself, the industry discovered at Terrifine enables us to establish the characteristics of the Archanthropian industrial stereotype.

The Archanthropian Stereotype

The primitive process of working stone by perpendicular impacts, which had produced the chopper, remained in use for roughing out hand axes and bifaces. It was eventually supplemented by a second series of movements whereby the piece of stone intended to become a tool was struck in a direction no longer perpendicular but tangential to its main axis (figure 47), an action that produced considerably longer and thinner flakes already somewhat similar to those eventually used by the Palaeoanthropians. Yet the number of forms of tools remained very small; they were limited to flakes put to use without further processing and "core tools," namely hand axes and bifaces. The development that took place between *Australopithecus* and the



47. Industry in the second stage. The primary sequence (a) has been enriched through the addition of a different type of impact (b). The tools, apart from flakes that can be used unprocessed, are the hand ax (c) and the biface (d).

Archanthropians thus consisted in the acquisition of a second series of actions. This was more than simply the addition of something new, for it implied a good deal of foresight on the part of the individual performing the sequence of technical operations. The Australanthropian making a chopper already had a mental picture of the finished tool because the pebble chosen had to be of suitable shape. Nevertheless, the range of possibilities was very wide, and the element of personal intervention may have been only slight. In the case of the Atlanthropians the situation was already very different: To make a hand ax one has to choose the point on the surface of a lump of stone at which to split off the large flake whose cutting edge will be the blade of the future tool. Furthermore a second operation has to be performed in order to reduce the initial flake to a shape that must be preexistent in the maker's mind. The same steps are obviously involved in the making of a biface, which presupposes a judicious choice of the pebble or lump of stone from which the almond-shaped tool will eventually be extracted.

Thus we see that the Archanthropians' intelligence was already highly complex, for their industry testifies to their use of two series of movements that had to be combined in order to produce a stereotyped form from a deliberately chosen lump of stone.

This observation raises some important issues. The early Paleolithic was a very long period lasting at least three or four hundred thousand years. During this immensely long period the evolution of industries was so slow that the same stereotype, with the addition of only a few new forms and a few refinements in execution, was preserved all the way from the Abbevillian to the late Acheulian. If human paleontology had more fossil records to work with, we might be able to measure the extent of the Archanthropians' physical development. Records are unfortunately so scarce that it is not yet possible today to relate the evolution of the skull (and consequently of the brain) to that of the millions of tools that have been found all over the Old Continent. It is fairly obvious that the earliest Palaeoanthropians were the direct successors of the last of the Archanthropians. Both fossil remains and tool finds strongly suggest that tools and skeletons evolved synchronously. We might say that with the Archanthropians, tools were still, to a large extent, a direct emanation of species behavior. Individual intelligence certainly played some part, but when we consider two bifaces of which one is Abbevillian and the other late Acheulian, we cannot escape the conclusion that the phyletic series can have included only very few Archanthropians of genius, for the industrial stereotype remained unchanged for several hundreds of thousands of years. The Atlanthropians, Sinanthropians, and Pithecanthropians would seem to meet quite closely the philosophers' rather vague concept of *Homo faber.* Throughout the greater part of our chronological existence (for only a few instants of geological time still remained to be covered), human technicity would thus seem to have been related more directly to zoology than to any other science.

The Palaeoanthropians

The dividing line between the lower and middle Paleolithic is somewhat blurred, as is that between Palaeoanthropians and Archanthropians. This is only natural if we regard evolution as a gradual phenomenon. The number of Palaeoanthropians known to us through fossil bone remains is relatively great, amounting to more than a hundred. Their geographical spread is considerable. Remains have been found in Belgium, Germany, France, Spain, Italy, Greece, Yugoslavia, the Crimea, Turkestan, Syria, Palestine, Iraq, North Africa, Abyssinia, Rhodesia, and Java. Moreover many of the fossils were found accompanied by an industry, and quite often they were found in their habitat. The exact period of their existence is difficult to establish, but we could suppose that it coincided roughly with the second part of the penultimate interglacial period and the first part of the last Ice Age, very approximately between two to three hundred thousand and about fifty thousand years before our era. They thus existed for an incomparably shorter time than the Archanthropians, a fact that is in line with the general acceleration to which human industries testify. To plot a chronological curve of evolution as attested by the available records is not an easy task, since the precise age of the specimens is still being debated by experts. However, what we know about the earliest (Steinheim, Saccopastore) as well as the most recent among them (Neanderthalians) allows us to suppose that the curve of their evolution was a continuous extension of that of the Archanthropians. The Palaeoanthropians have often been classified under the general designation of Neanderthalians. I believe with Weidenreich and Sergi that this usage is inadmissible and should be dropped. The term came into use as a result of a very common occurrence in the natural sciences, that of all subsequent fossil finds being subsumed under the first one to become known, in this case Neanderthal man. Human paleontology was at first unable to discern the differences within the series, and account was taken only of the general aspect of the fossils. It is evident today that very great differences exist between various "Neanderthalians" and that only the most recent West Eurasian group actually corresponds to the common type, namely, the Neanderthal fossil. I shall therefore describe as Neanderthalian only fossils generally associated with a Mousterian industry, characterized by a physical type close to that of the La Chapelle-aux-Saints man described by Boule and dating to somewhere around 100,000 to 50,000 years ago. These Neanderthalians are the only group for which a synthesis can be attempted; they are the only ones for which we have several specimens whose skeleton, habitat, and industry have been preserved and which offer enough elements of comparison to characterize a major stage in the development of humanity between the Archanthropians and *Homo sapiens.*

We saw earlier that the Neanderthalian skull represented the furthermost point of archaic human development. The continuing presence of an orbital ridge gave it a very peculiar cerebral morphology, with expansion occurring predominantly at the back of the cranium. It is therefore the last attested state of a human brain in which the prefrontal territories are still of relatively limited volume. Nevertheless, the Neanderthalians' cerebral capacity was equivalent to or greater than our own average capacity, a fact that greatly perplexed the paleontologists of the early twentieth century. We have to recognize that leaving aside the detail (admittedly an important one) of the smallness of the prefrontal areas, the brain of Neanderthal man largely corresponded to ours, particularly in the number of cells in the middle cortex.

Evidence of Neanderthal Man's Intelligence

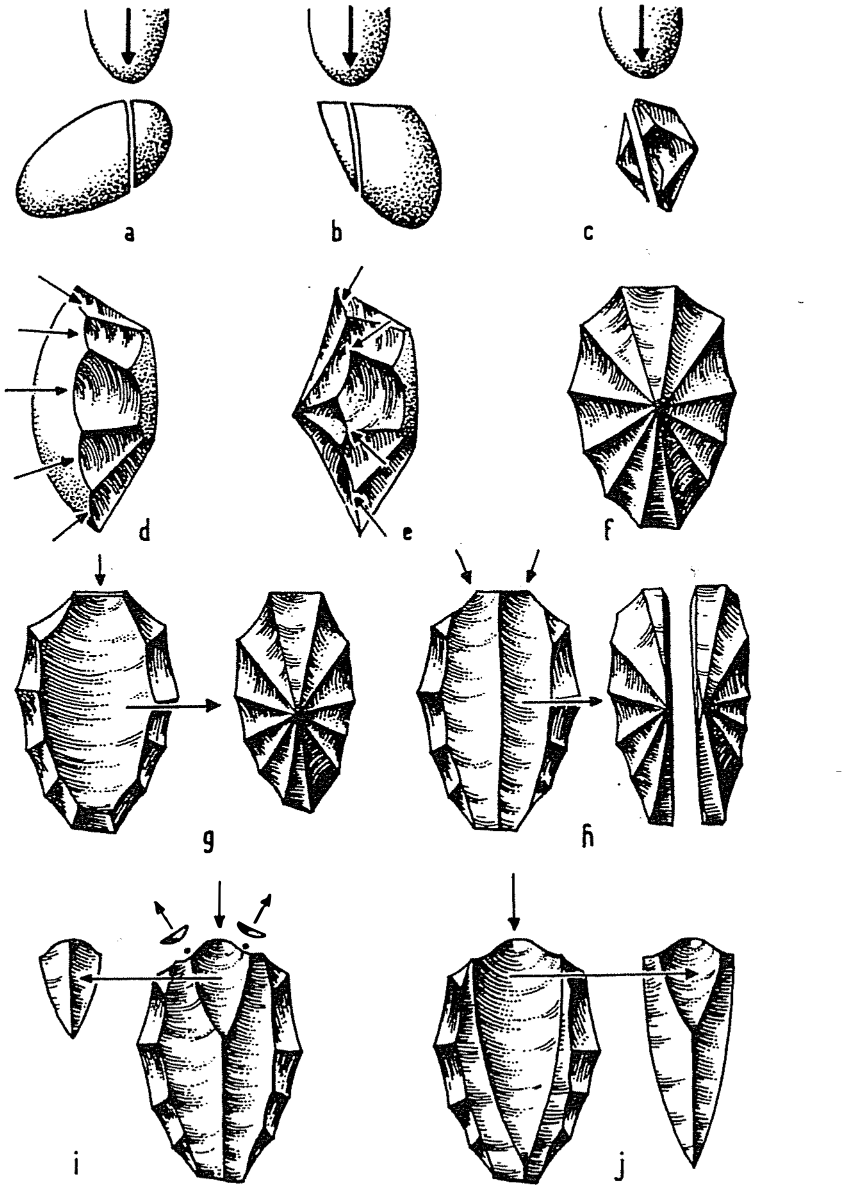
A great many middle Paleolithic habitats have been excavated, and despite the lamentably improvised character of most digs, a considerable amount of information concerning the life of Neanderthal man is available. What must be regretted is that almost without exception, the finest prehistorians devoted their skills to establishing correct chronologies rather than to recording the innumerable details that would have enriched our knowledge of the intellectual and social activities of the human beings of that time. Even so, some records concerning their technical activities, their habitat, and what has been classified as activities of a religious or aesthetic nature are available to us, information about their technical life being by far the most abundant.

The Levalloiso-Mousterian Technical Prototype

In the middle Paleolithic, stone tools underwent a most important development. The Archanthropians of the preceding period had still, to a large extent, obeyed the earliest tradition, and their tools—bifaces or hand axes—were still, like the choppers of the Australopithecinae, extracted from a lump of stone; the cutting edge of splinters obtained as by-products might or might not be put to use as a cutting blade. In the Acheulian the thinner edges of the bifaces produced by tangential impact meant that flakes detached from the matrix were larger, wider, and finer and could be employed for cutting. It was this development in the form of the biface that gave rise to the technique described by prehistorians as "Levalloisian." The lump of stone initially intended to become an almond-shaped tool became instead a source of flakes of predetermined shape, and it was these flakes that were eventually used as tools (figure 48). To achieve this result, the core had first to be roughed out into a rudimentary biface, then prepared for the extraction of a flake, and finally subjected to further successive extractions until it was used up. The preparation process could be developed to a point where a single impact of the percussion tool upon the core could at will produce a triangular point, a subcircular flake, or a long, narrow blade.

At the height of its evolution, which by the time of the Neanderthalians had long been reached, the Levalloisian technique represented the most elaborate method invented by humans for producing tools from flint. The tens of thousands of flakes, used-up cores, and discards found on the sites of large workshops to which Palaeoanthropians came to rough out their raw material provide us with a reasonably clear idea of the level of technicity they had reached. To extract a triangular point, it was necessary first to choose a lump of flint from which a core could be fashioned. Although carefully selected, this lump, which was quite likely to be imperfect, had to be placed in such a way that most of the imperfections could be eliminated in the course of the ensuing preparatory work or relegated to areas from which they could be eliminated later. Extraction of the point required at least six series of operations performed in strict sequence, each series being conditional upon the others and presupposing a rigorous plan. In these operations the two series of actions acquired by the Archanthropians were utilized and combined.

Another fact we should note is that the tool function had shifted from the mass initially intended to constitute the tool to the flake derived from that mass. The Australopithecine stereotype had been gradually left behind; we shall see later that this process is generally characteristic of the more developed industries. In other words, from being the tool itself the lump of stone has become a source of tools (as we shall see, an additional stage was to be introduced from the Upper Paleolithic onward). The blade or flake would then no longer constitute the tool but would be divided into sections providing the starting point for the making of the tool proper. A further aspect, that of the diversification of tools and their assignment to specific purposes, will be examined in chapter 4. This diversification (in relation to earlier periods) was already quite marked in Levalloiso-Mousterian times, with the proliferation of forms of scrapers, points, knives, notching tools, and so forth, derived from flakes detached



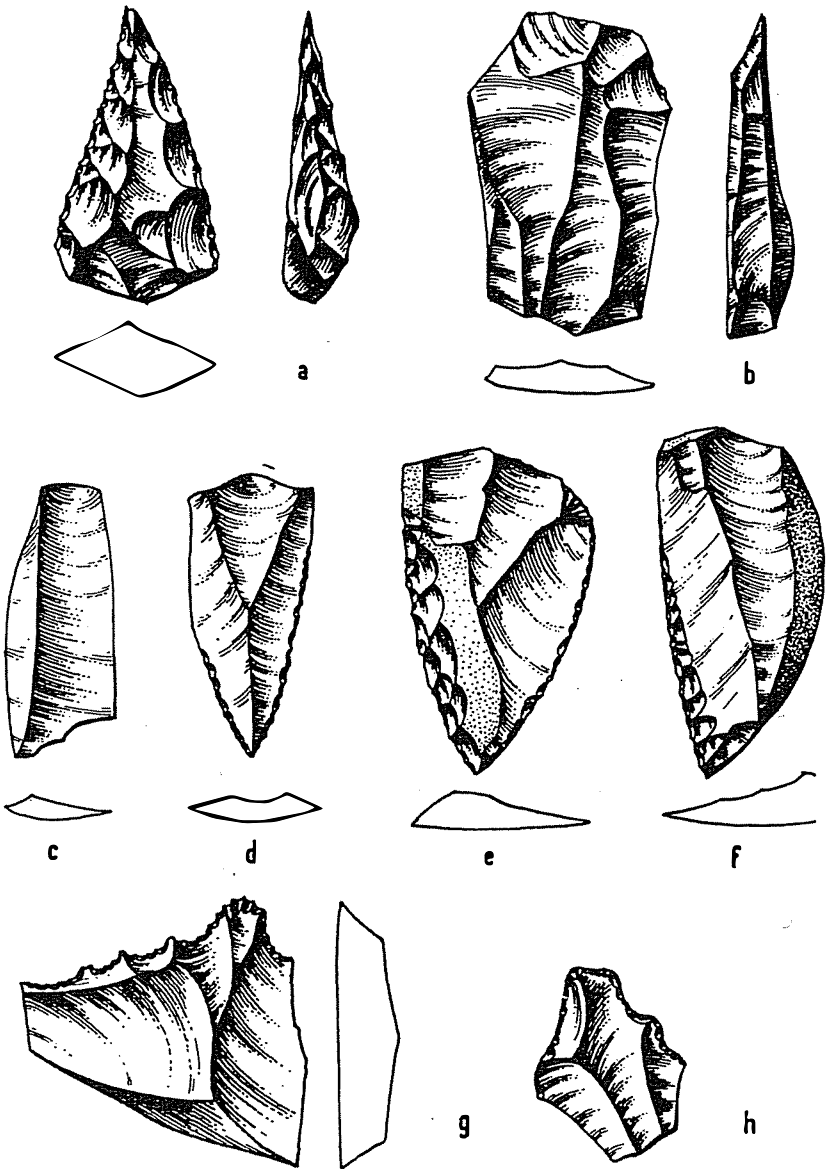
*48. Industry in the third stage. The first two series of actions (*a *and* b*) have led to the extraction of a prepared flake (*c*). The first and second series added together (*d*) produce a strongly dissymmetrical biface, the* core *(*f*) from which the Levallois flake (*g*) or a series of laminar flakes (*h*) can be extracted. Laminar preparation leads to the extracting of the Levallois point (*i, j*).*

from cores. The Palaeoanthropian stone industry thus implies an already highly developed technical intelligence. There is little reason to distinguish between the Palaeoanthropian technician's attitude and that of any technician of a more recent age—at any rate in strict terms of technical intelligence which presupposes a pyramidal brain area and areas of association identical with ours, at least as far as area 8. The records probably suggest a good deal more than that, but before we revert to the question of Palaeoanthropian intelligence, we must tackle the problem of language. In Levalloiso-Mousterian times all major problems of the flint industry had already been resolved, and it is directly from this stage that the evolution proceeded until the emergence of metals. Seen in this light, Neanderthal man appears as something very different from the last witness of the "Empire of the Anthropoids."

Available evidence concerning bone and wood industries is very scant. As regards the former, it seems that few changes took place from the time of the Australopithecinae onward. All that is known for certain is that the Neanderthalians sawed up deer antlers. On several occasions prehistorians have presented broken or polished bone splinters as evidence of an industry supposedly based on the direct use of natural splinters. They have even suggested that use was made of picks, coups de poing, or leatherworking tools made from the jawbones of bears, but this claim will not stand up to close technological scrutiny. As for woodworking, the evidence is indirect but precise: The absence of any tools made from fashioned bone, and consequently the extraordinary abundance of flint flakes bearing traces of use that indicate that they served for processing bone or wood, strongly suggest that woodworking played an important role. We can imagine the Palaeoanthropians using spears comparable, for example, to those of Australian aborigines (figure 49).

Habitat and Clothing

Few observations have been made of the Mousterians' habitat, a fact all the more regrettable as several hundred sites have been excavated, both in caves and in the open. From the sparse observations that do exist it seems evident that the Neanderthalians lived in huts. The disservice done to our picture of Paleolithic peoples by the legend of their withdrawing to caves as soon as the cold began to bite can never be sufficiently deplored. Caves are few and far between—in some regions measuring millions of square kilometers there are none at all—yet Palaeoanthropian traces have been found all over Africa and western Eurasia. Even more to the point, such observations as have been made show that the sites of industries discovered in



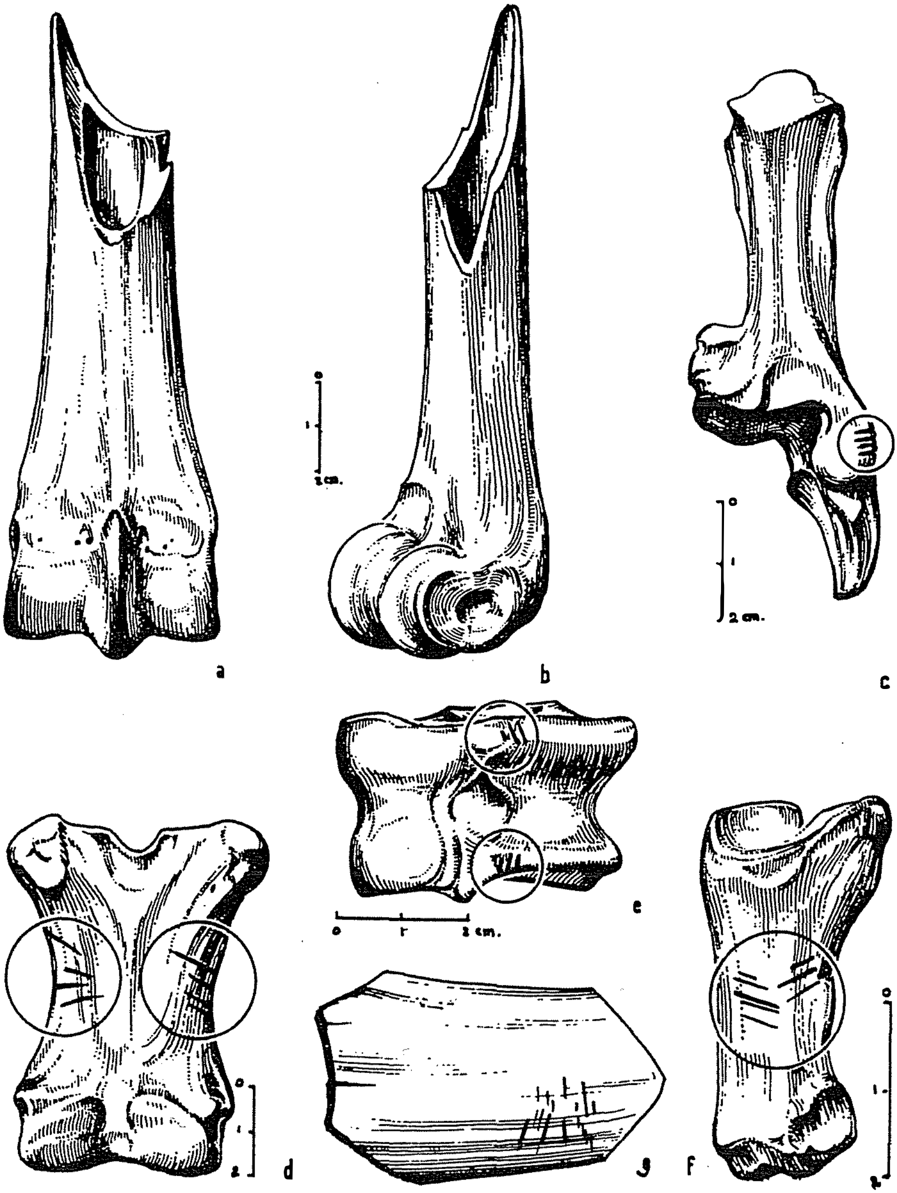
49. Levalloiso-Mousterian tools. The biface (a) survives; various other tools—Levallois flake (b), laminar flake (c), point (d)—have been added to it. By-products of core preparation can be fashioned into other types of points (e) or scrapers (f). Discard material can be used to make tools with serrated edges (g) or small scrapers (h).

the open were roughly circular, corresponding to the shape of huts that have disappeared. The interior organization of these huts, like that of the caves in which a minority of Neanderthalians did live, is known from one or two finds made in the West and in the U.S.S.R. The domestic organization to which they testify is far from developed: The Palaeoanthropians lived in a circle of a few meters' diameter, to the edges of which they gradually pushed the remnants of the food they consumed, animal bone fragments in particular. The domestic arrangements of Zinjanthropians and Sinanthropians do not appear to have been very different.

On the other hand, we know that slaughtering and skinning techniques (figure 50) were as advanced as those of flintworking, which is not surprising if we bear in mind that most tools were made for cutting and that stoneworking techniques are closely associated with the purpose for which the tools are made. Marks left by cutting blades on animal bones indicate that animals were skinned with the intention of utilizing the skins. Moreover finds of paw bones or claws of furred carnivores such as bears indicate that some skins, at least, were left with their claws intact much like our bedside rugs of today. From this it can readily be inferred that furs were used as covering. There is no way of distinguishing between their being used as clothing and as bedding, although the latter form of use is practically certain. It should not be forgotten moreover that Palaeoanthropians were geographically very widespread and that the way of life of African Palaeoanthropians was probably different from that of Palaeoanthropians living in Western Europe, who, although we should not exaggerate the rigors of the "Ice Age" climate, did nevertheless have to cover their bodies against the elements. We do not know how hairy the Palaeoanthropians were and are not even in a position to venture a hypothesis. What we do know is that as late as the twentieth century, in a climate as inclement as that of Patagonia, the last Fuegians lived naked, protected solely by an unprocessed animal skin used as an individual draft screen.

Evidence of Intelligence of a Not Strictly Technical Nature

Pondering the nature of human intelligence is the most personal of problems. Do we not exist only by virtue of our own awareness of existing? Traditional Church doctrine, even when applied to evolutionism, can resolve the difficulty of the gradual acquisition of human attributes by allowing that full humanity in the religious sense was bestowed by the grace of God upon a hominid that had reached sufficient matu-



50. Bones that had been split to facilitate extraction of the marrow have often been mistaken for tools (a and b); no traces of use are to be seen on such bones. Traces of cutting with a flint knife are, however, frequently found on joints (c, d, e) and paw bones (f). Bone fragments were often used as supports when sharpening flints and bear traces of such use (g).

rity. Trying to establish which link in the anthropoid chain it was that, through an act of grace, became the first man then becomes pointless. Whoever showed some concerns of a religious or magical nature was already, by definition, a man. Odd as it may seem, the traditional rationalist position is not very different from this except with regard to the prime mover, which becomes a nameless, loosely defined evolutionary force. As a result of their common cultural origins and their many efforts to reconcile obviously irreconcilable opposites, the theists and the rationalists of the eighteenth and nineteenth centuries inextricably superimposed *Homo sapiens,* man made in the image of God, upon God himself. Little was added to this view, well suited as it was to the vagueness of the sparse material evidence, in the first part of the twentieth century. When all is said and done, it was not unacceptable to either camp to have a vague and enigmatic monkey at the start of the ascent leading to *Homo sapiens,* the wise man, emerging into the full light of his intelligence by an act of God, through determinism or through his own efforts.

But can the question not be formulated in such a way that, instead of involving the dubious creature that allegedly stopped being a monkey to become our ancestor, it will directly address the modern human? We perceive our intelligence as being a single entity and our tools as the noble fruit of our thought, whereas the Australanthropians, by contrast, seem to have possessed their tools in much the same way as an animal has claws. They appear to have acquired them, not through some flash of genius which, one fine day, led them to pick up a sharp-edged pebble and use it as an extension of their fist (an infantile hypothesis well-beloved of many works of popularization), but as if their brains and their bodies had gradually exuded them. In a sense we may wonder whether techniques are basically really things of the intellect. Perhaps the distinction often drawn between the intellectual and the technical actually reflects a paleontological reality? In the second part of this book a question of the same order will arise in connection with the gradual transition from zoological to ethnic grouping. The techniques of Australanthropians and Archanthropians seem, in their very long development, to have obeyed the rhythm of biological evolution; chopper and biface seem to form part of the skeleton, to be literally "incorporated" in the living organism. With the emergence of new intellectual possibilities, techniques began a dizzying ascent, but the curves of their evolution followed the lines of phyletic evolution so closely that we must ask ourselves whether they are not simply an extension of the general development of species.

If technicity is merely a zoological fact ascribable to the specific characteristics of anthropoids, we are more readily able to understand the earliness of its first appearance, the slowness of its early development, and from the moment when it became cast in the intellectual mold of *Homo sapiens*, its dominance over other characteristics. The reason why we find Palaeoanthropians so particularly engaging is that in them we witness the first upsurge of new aptitudes of the brain that both counterbalance and stimulate technicity.

Activities of a nature not related to mere survival have been observed in primates. Play-related and communicative behavior should be considered separately because play and display represent a special form of survival behavior unconnected with technicity. But we may legitimately ask ourselves what lies behind the action of the chimpanzee tracing the outline of its own shadow on a wall, the gorilla daubing with excrement or, where these are made available, with paints, or endlessly making and destroying sawdust patties. Such activities are not art or magic any more than piling up crates in order to grab a banana is a technique, but they are an advance signal of a development that will be observed again in anthropoids a good deal further along the line. The reflective intelligence which not only grasps the relationship between different phenomena but is capable of externalizing a symbolic representation of that relationship was the ultimate acquisition of the vertebrates. It cannot be conceived of before the anthropoid stage, for it is the fruit of a cerebral organization whose seed was sown at the time of the freeing of the hand and which came into full flower with the emergence of *Homo sapiens*. Where this acquisition takes the form of technicity, the faculties of reflection and the neurovegetative organization of the association areas of the cortex merge into one; where it is a matter of "gratuitous" intellectual operations, the gradual development of the frontal and prefrontal areas appears to have entailed a progressively growing faculty for symbolization. Archaeological evidence of such activity—which goes beyond technical motor function—is elusive for the early Quaternary, but by the Palaeoanthropian stage some archaeological evidence begins to become available. These activities, the earliest of an aesthetic or religious character, can be classified in two groups as reactions to death and reactions to shapes of an unusual or unexpected kind. Prehistoric records are very scanty. The most that remains of the activities of a once living human group are some worked stones, bones, or pieces of mineral which for some reason may have attracted the attention of the fossil human. Prehistorians must resign themselves to doing without the evidence that would have been most significant—gestures, sounds, arrangements of objects—and be content with imperishable records which in the majority of cases consist of discarded items such as lumps of flint from which tools had already been extracted or osseous remains of bodies or meals. Bone records have been used extensively in attempts to reconstitute the thinking of the fossil human, and some results of such efforts have achieved classic status.

The "Bone Cult"

Extensive use has also been made of the frequency of occurrence of certain parts of human or animal skeletons or the manner of their arrangement. Records in this category can be classified under three main headings, those pertaining to the bear cult, the skull cult, and the jaw cult, respectively.

The bear cult was deduced from much research in European caves containing veritable boneyards of cave bear remains. Some observers noticed that long bones—femurs, tibias, or humeri—often seemed to be laid along the walls of excavated sites and also that animal skulls were generally found in corners, as though deliberately placed there. The bear cult theory appeared to be confirmed when a Swiss prehistorian, Emil Baechler, published his find (made at the Drachenloch in 1920) of "chests" made of limestone slabs and filled with rows of bear skulls. Unfortunately, only sketches made by the author long after the event were available as means of ascertaining the precise nature of this extraordinary find, and Baechler's views have been very vigorously challenged. Careful searches in other caves revealed that the probable explanation for most of his observations was that bears settling down to hibernate had made recesses in the clay floors by scratching. As a result of movements inside the cave, the long bones would naturally have been aligned along passageways and would have tended to accumulate under vaulted sections of the cave roof that protected them. Such skulls as did not accidentally roll into corners or end up between two stones would certainly have been crushed and would no longer exist. Not a great deal is heard about the bear cult today, except perhaps for a cave in Austria where a bear skull appears to have been picked up from the floor and placed in a recess, but there is no formal proof that this was done by a Neanderthalian. Although the act may legitimately be considered to betoken respect, it falls far short of the intense bone worship that was once thought to have drawn Neanderthal man into the caves.

The question of a skull cult arose in connection with the Sinanthropians. During the excavation of the Choukoutien cave it was noticed that fragments of skulls were found in certain sectors rather than others, and it was thought that skulls might have been placed on top of stones deliberately for a purpose connected with worship. The fact that such an idea should have caught on is surprising when we consider the geological conditions of the dig, which was conducted in breccia almost 50 meters thick, often requiring to be loosened with explosives. It is surprising too when we consider the fragmented state of the crushed and scattered bones found, and still more surprising when we look in vain for any precise and detailed drawing, made at the actual time of discovery, on which the interpretation of the position of the remains might have been based. In prehistory, ideas resulting from the mulling over of impressions that can no longer be verified come too often to be regarded as certitudes.

The evidence is a little less flimsy in the case of the Archanthropians and Palaeoanthropians. A single set of facts has been observed in a fashion that, although incomplete, may be considered significant. When H. -C. Blanc entered the cave of Monte Circeo in 1939, the Neanderthalian skull he found was lying on the ground apparently surrounded by a few stones, while some animal bones seemed to be arranged in an intentional pattern near the walls. Here we have evidence that a Neanderthal man's skull, minus its jawbone and separated from other parts of the skeleton, was placed on the floor of a cave which, as the almost total absence of tools suggests, was not a regularly frequented habitat.

The jawbone cult has quite a different origin, being entirely a matter of statistics. It was noticed that jawbones were found with exceptional frequency—much more frequently than brain boxes—among human vestiges from the Australopithecinae to the end of prehistory. By linking up this fact to certain parallel phenomena in ethnography, particularly the fact that Melanesian women wear their deceased husband's jawbone suspended from their necks, it was suggested that a jawbone cult might be the explanation for the frequent occurrence of these fossils. It is surprising that no serious attempt was made to verify whether there might not be other, less metaphysical reasons for the jawbone's resistance to destruction.

As it happens, the mechanical and chemical destructibility of bones is related to their shape and compactness: the jawbone, which as we saw in chaper 2 is the cranium's principal component, is particularly resistant. To verify this fact, I took four homologous parts from the skeletons of wolves, hyenas, and foxes scattered in the Mousterian strata of Arcy-sur-Cure, on the one hand, and of Palaeoanthropians found in Europe, on the other. In the case of the three batches of animal bones from Arcy-sur-Cure we know that we are dealing with remains of animals killed by hunters mixed with those of animals that died in their lairs. These bone remnants found in situ, intermingled with other fragments (broken by human hand) of bones of animals commonly used as food (reindeer and horses), can hardly be suspected of pertaining to a cult. The percentages obtained are convincing:

	Wolf + hyena + fox (Arcy-sur-Cure)	Palaeoanthropians (Europe)
Teeth	7.1%	1.05%
Long bones	8.8	1.00
Upper jawbone	26	17.5
Mandible	54	62

So we must either believe, against all archaeological evidence, that the Palaeoanthropians venerated the jawbones of foxes inside their earths or on scrap heaps, or else we must accept the fact that the jawbone cult is an artifact produced by imperfect experimentation and ought to be consigned to the realm of scientific folklore.

To sum up, evidence of the so-called bone cult imputed to Palaeoanthropians is so tenuous that it can really be reduced to just one fact—the presence of the Monte Circeo skull on the cave floor. The fact is important and coincides with other evidence of early human thought reaching beyond simple material technicity. But it is always a mistake to push evidence too far.

Burial Places

The practice of burying the dead is a significant feature of concerns normally associated with religious sentiment. In the late nineteenth century the subject was in fact one of those most hotly debated in pro- and antireligious polemics. It is difficult to analyze the extent to which spirituality is implied in the funeral practices even of still living peoples, but we may be sure that the development of such practices corresponds to that of essentially human affectivity and that the symbolism of interment became oriented toward the supernatural at a very early stage. This does not, however, supply us with a key to what Palaeoanthropians thought about life after death. Affectivity toward the dead belongs to the deepest levels of psychological behavior; even when, as in present-day societies, religious superstructures are crumbling, burial practices lose none of their importance.

Unfortunately for the study of the Palaeoanthropian mind, observations of a genuinely scientific nature are generally lacking. Such records as there are can be divided into two groups. In the first, human bone remains occur in a broken state and without any anatomical connection between them, much in the same way as remains of animals used as food. It is hard to tell whether they represent traces of cannibalism or of bodies abandoned on the ground after death and scattered by wild animals. A few cases appear to suggest the former, but the majority, from the Australanthropians to Neanderthal man, imply simple abandonment.

The second group covers recognized burial grounds. In a number of cases bodies have been found lying full-length or bent at the waist in what are still identifiable trenches. We may presume without great risk of error that all bodies of which at least part of the skull and several long bones belonging to the same individual have been found were interred, for there is no example of a body having been preserved at the entrance to a cave unless it was buried at the time of death.

The Palaeoanthropians then buried their dead—or, more precisely, it was the Neanderthalians (the last of the Palaeoanthropians) that did so. No case of inhumation dating back to before the beginning of the last Ice Age appears to have been discovered. We are therefore dealing with a practice whose origin hardly predates the moment when the species assumed its present-day form. Although the Neanderthalians' facial apparatus was still very archaic, their brain was large and its workings probably did not differ very much from ours.

Other Evidence

There is some evidence that Palaeoanthropians had an affective life of the same order as that of *Homo sapiens*. The presence of red ocher in Mousterian strata has been reported on a number of occasions. Coloring is not synonymous with art, and we should once more beware of overinterpreting the data. But the importance of ocher from that point onward and throughout the early stages of the existence of *Homo sapiens* was to be so great that its use in Mousterian times cannot be considered altogether devoid of significance.

In the particular case of Arcy-sur-Cure, some fossil shells and nodulous lumps of iron pyrites of extraneous origin were discovered in a late Mousterian layer (see part II, figure 128). At El Guettar in southern Tunisia, a curious heap measuring almost a meter across and consisting of globular lumps of limestone interspersed with fragments of bone and flint were found in a developed Mousterian environment.

If we survey the considerable literature that has sprung up around the subject of the Palaeoanthropians' religious sentiments, the actual evidence is rather small. The most striking feature is the lateness of certain important facts: Only in the very last Palaeoanthropians does the capacity for symbolic thought begin to become apparent. The Monte Circeo skull, a few burial places, a little ocher, a handful of curious stones make up the thin halo of immateriality around the head of Neanderthal man. Yet, flimsy as it may be, this halo is of capital importance because its appearance coincided with the precise moment when the paleontological record shows that the brain was about to attain its present level of development. Despite their enormous orbital ridges, the Neanderthalians were not, as nineteenth-century evolutionists imagined them to be, Anthropopithecinae escaped from the Tertiary. What is even more important to acknowledge is that they actually represent a transition to our own prehistory. Their industry, whose discoveries in some cases extended almost as far as metallurgy, was transitional, and so was their status in what we regard as the sphere of human thought proper.

It has taken us surprisingly long to recognize Neanderthal man's real place. Every possible unconscious artifice was employed in order to deny that he was our next-door neighbor, that we were his heirs: The most long-lived of these tricks, still occasionally brought out today, consists in affirming that *Homo sapiens* was already living at the time and the Neanderthalians were merely survivors in what was already a "better" world. We can imagine the existence of considerable racial differences at the time, perhaps of the order of those between Europeans and Australian aborigines today, but there is absolutely no point in reviving the hypothetical *Homo presapiens* whose intelligence supposedly penetrated the Palaeoanthropians' thick skull at long range. Even supposing that this were true, it would not alter the far more obvious fact that the Palaeoanthropians understood and lived out the ideas allegedly put in their minds by beings more developed than themselves. The real truth, as more carefully conducted excavations may show in the future, is probably simpler: During the fifty millennia of Neanderthal man's existence, the transition from the last archaic anthropoids to the first representatives of our own species took place gradually, affecting body, brain, and actions alike.

The Language of "Prehominids"

We possess no direct means of studying language before writing. Attempts have been made to link the exercise of speech to the shape of the mandible or the size of the insertion ridges of the tongue muscles, but such speculations make little sense. The problem of language is not a matter of lingual muscles.[9] Tongue movements served for processing food before they had a phonetic function, and the limited freedom of movement of Mauer man's tongue (not an easy fact to demonstrate) matters rather little. The point at issue is neuromotor organization and the quality of cerebral projections. The answer to the problem of language does not lie in the mandible but in the brain. Useful insights can be derived, however, from a study of the points of insertion of the muscles of the face and jaw with regard to the degree of flexibility of the organs of phonation and mimicry. Such scant information as we possess suggests that the muscles of expression became progressively more refined with each anthropoid stage, thereby merely continuing a path already outlined in the mammals, whose facial expressions sometimes play an important role.

The language of fossil anthropoids is a question that must, in my view, be approached in a roundabout way. In chapter 2 we saw how, in the higher vertebrates, the field of responsiveness developed to form two poles between which the neuromotor apparatus coordinates the actions of the face with those of the hand. We also saw, at the beginning of this chapter, that in the physiology of the cerebral cortex the manual projection fibers are very close to the facial fibers. It is moreover known that areas 8 and 44 of the frontoparietal cortex play a role in two language anomalies, one involving the inability to form written language symbols (agraphia) and the other the inability to organize vocal symbols (aphasia).

A link therefore exists between the hand and the facial organs, and the twin poles of the anterior field attest their equal participation in the construction of communication symbols. Can these facts, which are true of the modern human, be projected backward to a time when writing did not exist?

The phenomenon of agraphia is not due to neurological connections that became established in humans since the invention of writing (if it were, Australian aborigines would be incapable of learning to write) or to connections that develop in children learning to write (if it did, learning to write would not be possible for adults). We are therefore entitled to think that the relationship between area 44 and the pyramidal centers of the face is of the same nature as that between the base of the second frontal convolution and the pyramidal centers of the hand. In primates, facial and manual organs maintain equal technical activity: Monkeys work with their lips, their teeth, and their hands, just as modern humans speak with their lips, their teeth, and their tongues and gesticulate or write with their hands. To this should be added, however, that humans also use the same organs for making things, but that a shift has taken place in the relative positions of the two functions: Before writing, the hand was used principally for making and the face for language, but with the invention of writing the balance between the two was restored.

To put it another way, humans, though they started out with the same formula as primates, can make tools as well as symbols, both of which derive from the same process or, rather, draw upon the same basic equipment in the brain. This leads us to conclude, not only that language is as characteristic of humans as are tools, but also that both are the expression of the same intrinsically human property, just as the chimpanzee's thirty different vocal signals are the precise mental counterpart of its use of several sticks to pull down a banana hanging overhead—in other words, no more a language than fitting the sticks together is, properly speaking, a technique.

From this starting point, a paleontology of language could perhaps be attempted, but it would only be a skeleton of a science, for there is little hope of ever recovering the living flesh of fossil languages. One essential point that we can establish, however, is that as soon as there are prehistoric tools, there is a possibility of a prehistoric language, for tools and language are neurologically linked and cannot be dissociated within the social structure of humankind.[10]

Can we go any further than that? There is probably no reason, in the case of the earliest anthropoids, to separate the level of language from that of toolmaking: Throughout history up to the present time, technical progress has gone hand in hand with progress in the development of technical language symbols. It is possible, in the abstract, to conceive of a purely gestural technical education; in practice, even completely silent instruction will actuate a reflective symbolism in both teacher and pupil. The organic link appears to be strong enough to justify crediting the Australopithecinae and the Archanthropians with language at a level corresponding to that of their tools. Where comparative studies of tools and skulls tell us that the rate of development of industry corresponded to that of biological development, language must have been very primitive indeed, but it undoubtedly amounted to more than vocal signals. The characteristic trait of the "language" and "techniques" of the great apes is that they are resorted to spontaneously in response to an external stimulus and are just as spontaneously abandoned, or fail to appear, if the material situation triggering them ceases to exist or does not occur. The making and using of choppers or bifaces must be ascribed to a very different mechanism since the operations involved in making a tool anticipate the occasions for its use and the tool is preserved to be used on later occasions. The same is true of the difference between signal and word, the permanence of a concept being comparable to that of a tool although its nature is not the same.

We shall revert to the concept of operating sequences in chapters 7 and 8, but mention of it must be made here if we are to understand the link between technics and language. Techniques involve both gestures and tools, sequentially organized by means of a "syntax" that imparts both fixity and flexibility to the series of operations involved. This operating syntax is suggested by the memory and comes into being as a product of the brain and the physical environment. If we pursue the parallel with language, we find a similar process taking place. On the basis of what we know of techniques from pebble culture to Acheulean industry, we could adopt the hypothesis of a language whose complexity and wealth of concepts corresponded approximately to the level of those techniques. The language of *Zinjanthropus,* with his single series of technical actions and small number of operating sequences, would then have had a complexity and wealth of symbols scarcely greater than that of the gorilla's vocal signals, but, unlike the latter, it would have been composed of already available and not totally determined symbols. The operating sequences of the Archanthropians with their doubled series of actions and their five or six different tool forms were already much more complex, and the language we may credit them with was considerably richer, though probably still limited to expressing concrete situations.

The early Palaeoanthropians were the direct inheritors of this situation, but their possibilities became gradually extended. The exteriorization of nonconcrete symbols took place with the Neanderthalians, and technical concepts were thenceforth overtaken by concepts of which we have only manual operating evidence—burial, dyes, curious objects. This evidence, however, is sufficient to establish with certainty that thought was being applied to areas beyond that of purely vital technical motor function. The Neanderthalians' language probably differed only slightly from language as we know it today. It was reserved essentially for concrete situations and used for the purpose of communication during the performance of activities, a prime function in which language and technical behavior are closely combined. It was also used for post facto transmission of the action symbols in the form of narration. This second function must have emerged gradually in the Archanthropians, but this supposition is difficult to demonstrate. Lastly, a third function emerged in the course of the Palaeoanthropians' development, one in which language went beyond the reflection of concrete situations to express sentiments of a less precise nature, of which we know with certainty that they were to some extent religious. These new aspects will be discussed extensively later on; here we need only note that they emerged at the time of the Palaeoanthropians.

The origin of language in anthropoids preceding *Homo sapiens* thus seems to have been closely linked with technical motor function. Indeed the link is so close that employing as they do the same pathways in the brain, the two main anthropoid characteristics could be attributed to one and the same phenomenon. The early anthropoids' technical activity suggests an extremely slow but roughly synchronous evolution of tools and of the skull toward the status of *Homo sapiens.* No reliable evidence available to date, with the exception of records relating to the most recent period, suggests that early anthropoids performed other than vital operating sequences. If language really sprang from the same source as technics, we are entitled to visualize language too in the form of operating sequences limited to the expression of concrete situations, at first concurrently with them and later involving the deliberate preservation and reproduction of verbal sequences going beyond immediate situations. The fact that has profoundly altered the philosophical status of fossil man in the last few years is that we have been forced to accept the existence of *Zinjanthropus* as a human being walking upright, making tools, and, if my argument is correct, speaking. The image of this early man in no way fits in with what two centuries of philosophical thought had accustomed us to see. Facts now show that the human is not, as we had become used to thinking, a kind of monkey gradually improving itself; the human is not the majestic pinnacle of the paleontological edifice; from the earliest moment at which we pick up the trail, the human is something other than a monkey. At that moment, humans still have a very long way to go, but their journey will be not so much a matter of biological development as of freeing themselves from the zoological context and organizing themselves in an entirely new way, with society gradually taking the place of the phyletic stream. If we absolutely insist on finding the monkey who was at the beginning of it all, we must look all the way back to the Tertiary. But the already human picture we now have of the Australanthropians changes the very foundations of the problem of our origins. Their bipedalism, which was certainly not newly acquired, implies a considerable distance between them and the ancestors of present-day monkeys, somewhat comparable to the distance between the lineages of the horse and the rhinoceros: In other words, it implies that we may one day discover an animal that was neither monkey nor human but was potentially capable of becoming the ancestor of both.

4 The Neanthropians

The Physical Past and Future of Homo Sapiens

We saw earlier the general evolution of zoological species whose development followed the same course as ours involved successive "liberations," the two most important of which were the freeing of the head in theromorphous reptiles of the Paleozoic era and the freeing of the hand in Australanthropians at the very end of the Tertiary period of the Cenozoic. The "liberations" that occurred during the evolution of anthropoids were the freeing of the brain and, consequent upon it, the loosening of certain zoological bonds. It is this evolution that we now propose briefly to survey.

By the time of the Australanthropians the freeing of the base of the skull had already been accomplished and, as we have seen, the cortical "fan" had begun to open out. Quite early, not later than the Palaeoanthropian stage, the pyramidal motor apparatus and the contiguous areas of association reached a development roughly equivalent to the modern human's. Innumerable objects bearing witness to the Palaeoanthropians' highly developed technicity are there to prove it. The same phenomenon of stabilization of acquired structures, the same overtaking of existing systems by new ones, must therefore have taken place in the evolution of the brain. By the time of *Australopithecus,* the hand must have been almost as it is today. By the end of the Archanthropian stage, the development of the technical brain was practically complete.

The stabilization and eventual overtaking of the technical brain were of particular importance to the human species. Had development continued toward ever-increasing corticalization of the neuromotor system, our evolution would have stopped at a stage comparable to that of the most advanced insects. What happened instead was that the motor areas were overtaken by zones of association having a very different character that, instead of orienting the brain toward ever more developed technical specialization, opened up unlimited possibilities of generalization—unlimited at any rate by comparison with the possibilities offered by zoological evolution. Throughout our evolution, ever since the reptiles, the human appears as the inheritor of creatures that escaped anatomical specialization. Neither human teeth nor hand, neither human foot nor, when all is said and done, brain has attained the perfection of the mammoth's teeth, the horse's hand and foot, or the brain of certain birds—with the result that humans have remained capable of just about every possible action, can eat practically anything, can run and climb, and can use the unbelievably archaic part of their skeleton, that is, their hands, to perform operations directed by a brain superspecialized in the skill of generalizing. In the foregoing pages we have covered much of the path that took us there, but it still remains for us to explain how the last liberation was achieved.

The Skull of Homo sapiens

The evolution of the Anthropian skull seems clearly to reflect a threefold process: the mechanical disengagement of the back of the skull through the acquisition of erect posture, the mechanical disengagement of the forehead through progressive reduction of the roots of the teeth, and an increase in brain volume until the Neanderthalian stage, followed by the brain's progressive invasion of the frontal areas unaccompanied by further increase in volume. The fact most characteristic of the Neanthropians is the gradual fining down of the facial frame, which in the most highly evolved individuals of today's races, whether black, white, or yellow, has only a very slight support structure. Except in a few small primitive groups such as Australian aborigines, this is not a racial feature in the ordinary sense, for the most highly evolved forms are to be found in all major racial groups. It is as though the basic design were independent of racial variations or, more precisely, as though the structural drift were a matter of very slow but synchronous gradual development of the whole of humankind—which would explain why, notwithstanding variations in skin color, height, blood groups, dental prognathism, and many other traits, *Homo sapiens* is the only human species alive on earth today. This bears out G. G. Simpson's concept of "macro-evolution," the whole of the phylum going through stages of adaptation that involve all the fundamental typological characteristics. It was a development or "drift" of this order that conditioned the succession of Archanthropians from Australanthropians, Palaeoanthropians from Archanthropians, and, finally, of

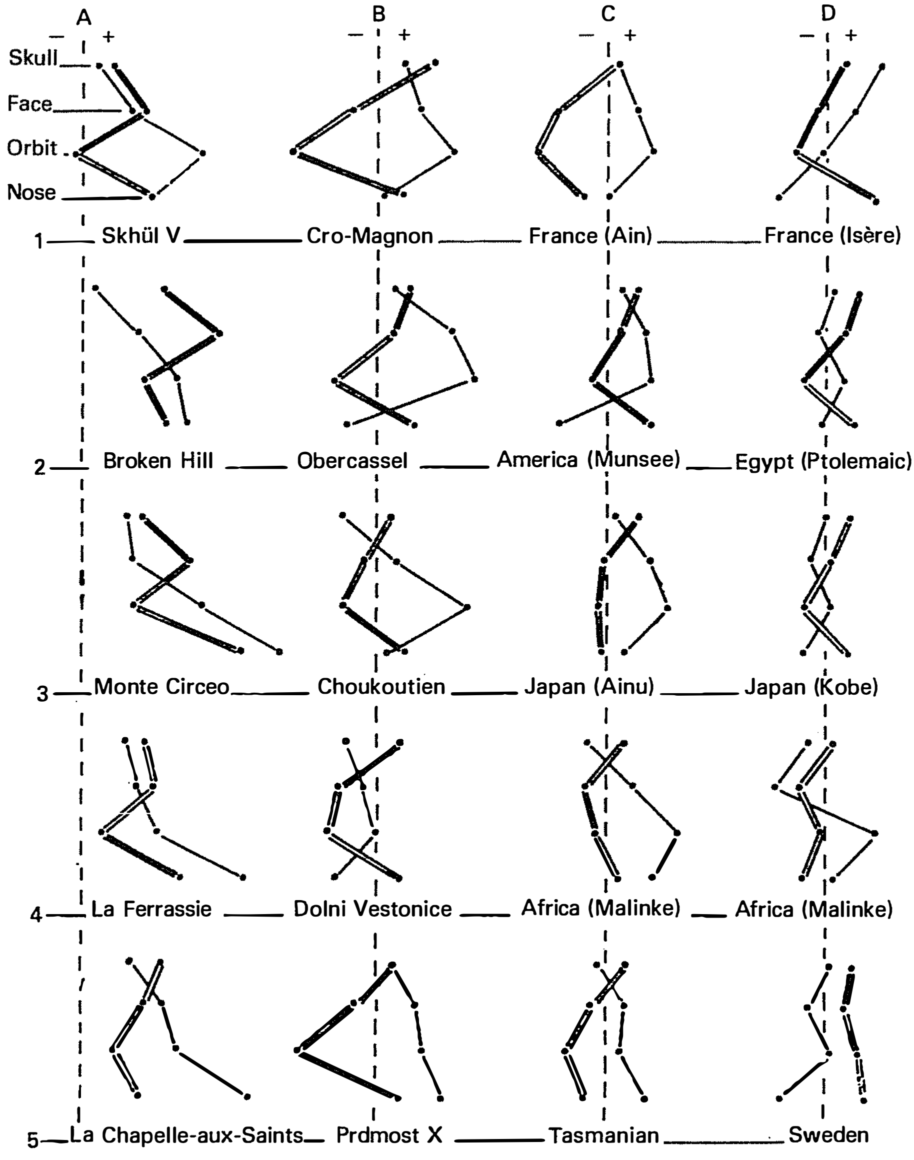
Neanthropians from all others. It is small wonder therefore that mechanical equipoise diagrams show no distinction among the black, white, and yellow races.

For over a century and a half anthropologists have been inventorying racial differences in the human skeleton and particularly the human skull. Curiously the pickings have been rather slim. It is far easier to determine the racial origin of a skull by simply looking than to prove the point mathematically with compasses and figures. The loose network of measurements confounds, without any possibility of differentiation, those characteristics that can properly be called racial with much more general ones that reflect specific stages of development. Moreover, significant microracial values—which are a matter of subtle variations in the curve of an orbit or all but imperceptible inflexions of the cranial convexity—simply cannot be quantified. But if measurement methods do not faithfully render either the basic design or fine racial distinctions, they do shed a useful light on variations in general proportions, so study of a chronological series of individuals covering the whole period for which *Homo sapiens* is known to have existed may help us to establish the extent to which we have evolved since our earliest days.

Graphic Profiles

The evolution of general proportions can be expressed through the relative length and width of the cranium, the face, the orbit, and the nose at several successive moments in time. The data can be used to plot the profile of lengths in relation to widths, and both of these in relation to a statistical mean established for present-day *Homo sapiens* of different races. Figure 51 shows various Palaeoanthropians (*A*), various fossil men of the Upper Paleolithic from Europe and Asia (*B*), modern men of the most archaic type taken from each major racial group (*C*), and men of the most developed type selected from the same racial groups (*D*).

In the case of the Palaeoanthropians (*A*), we find that the general picture is the same for all dimensions: All are considerably larger than the modern average, the skull is very large and elongated, the face is enormous and very high (except in the case of the man of La Chapelle-aux-Saints, who is toothless), the orbit is large and wide, and the nose extraordinarily large and wide. These Palaeoanthropian proportions are not found in any known Neanthropian, however primitive. They clearly belong to a stage of homogeneous characteristics that was left behind many thousands of years ago.



51. Graphic profiles of Palaeoanthropians and of Homo sapiens. *The profiles were established by comparing the lengths and widths of Palaeoanthropian skulls, faces, eye sockets, and noses with the corresponding averages for modern humans of all races. The picture thus obtained of the main proportions of the skull is interesting:* A, *Palaeoanthropians;* B, *fossil* Homo sapiens; C, *modern individuals with skull proportions similar to those of* B; D, *modern individuals of the type most divergent from* B. *The examples were taken from all continents in order to demonstrate that the phenomena are not racial but, rather, testify to the general evolution of the species. All the* D *individuals illustrate the intensity of facial regression during the last few millennia.*

In the case of fossil Neanthropians (*B*), irrespective of whether they were found in France, Germany, Czechoslovakia, Russia, or China, the uniformity of type is very striking. The external features are so manifest that anthropologists created the "race of Cro-Magnon" to describe them—although in fact Cro-Magnon is not a race but a type corresponding to a particular stage. Except for the cranium, which is long but a good deal smaller than the Neanderthalian's, the Cro-Magnon type differs from the Palaeoanthropian in every respect. The face is very low, wide, and short; the orbit extremely low and wide; the nose of medium length and narrow. The fossil Neanthropians date back to about 30,000 B.C., as against around 50,000 B.C. for the most recent Neanderthalians. During the intervening twenty thousand years a transformation took place; the precise terms of it are still largely obscure because of a lack of fossils or of suitable interpretations of such fossils as are available.

Some of the known fossils, such as skull V from Skhül, classified as Neanderthalian with Neanthropian characteristics, or skull X from Prdmost, classified as Neanthropian with Neanderthalian affinities, seem to indicate the direction in which the evolution took place. Comparing the Skhül cranium with those from Broken Hill and Cro-Magnon, we find that the characteristics of the skull and the face are attenuated Neanderthalian ones, while the proportions of the orbit and nose are of the Cro-Magnon type. In other words, the face is still wide and high, but the orbits are low and the nose has become thinner. Going on to compare Prdmost X with La Chapelle-aux-Saints, we find that, except for a considerable reduction in length and height, the general proportions are the same. The Cro-Magnon type does not yet seem very different from the Palaeoanthropian, or rather, the differences between them are more a matter of quantity than of substance. If we compare the two "transitional" individuals with each other, we find that in both cases the changes involve the orbital height. The facial height of the Skhül fossil is still considerable, while the Prdmost face seems to have dwindled. The tooth rows of both are of Neanthropian proportions, showing a general reduction of the roots and, so far as the molars are concerned, a reduction of the crown between the first and last molars. In other words, both show an appreciable regression of the wisdom tooth and suggest a facial balance in which the function of the first molar is preponderant. That being so, the whole orbitomalar region begins to undergo a profound change which, at this stage, takes the form of a nonharmonious reduction in facial height and a shift of the facial structure of the supraorbital bloc into the lateral framework of the orbits.

Thus the "Cro-Magnon type" appears as the first stage following the completion of the prefrontal development process. Reduction of the tooth row and acquisition of a facial balance no longer based on canines as well as molars, though predominantly on the molars, determine this type of *Homo sapiens* to which all the known fossils belong. In Europe it persists until the Mesolithic and then gradually disappears. Survivals of the archaic *sapiens* type have been reported by many authors and have given rise to hypotheses—some of which are rather bold—concerning the origin or the geographical distribution of the "race of Cro-Magnon." In fact the structural type is a universal one and can still be found, with variable frequency, in all parts of the world (*C*). It is relatively common among Melanesians and Australian aborigines, but some isolated fossils have been found in America, Europe, and Africa as well. In each case it is a matter of general proportions only (long cranium, very short face, very low orbits) and not of racial features in the strict sense.

The Evolution of Neanthropian Types

A common thread of general evolution, that slow and continuous "drift" so clearly attested by so many facts for many species of animals, appears to run through the multiple paths of racial evolution. In the case of anthropoids the drift seems to have become gradually accelerated: Australanthropians and Archanthropians account for 70 percent of the Quaternary period of the Cenozoic era, Palaeoanthropians for 25 percent, and Neanthropians for only 5 percent. Does this 5 percent of the Quaternary period, which represents the past of our own species, suffice to reveal a significant development from the man of Cro-Magnon to man as he is today? The time span that separates the two is a little over 30,000 years, and it would indeed seem that certain important changes have taken place during that time.

First of all we must understand under what conditions the comparison has to be made. So far as the modern human is concerned, we have at our disposal thousands of individual samples covering the full range of racial variations. Except for some scattered and isolated peoples such as certain Eskimos, the Australian aborigines, and a few African groups, each racial type exhibits such a wealth of racial variations that the picture we obtain can never be more than a statistical one. In other words, unless a precise geographical identification of the individual is possible, our definition must remain very broad, for example, "Mongoloid skull from Southeast Asia" or "Alpine type." In the case of fossil man the opposite is true: We have in our possession just a few individuals separated by thousands of years and, sometimes, by great distances. Racial type is no longer apparent among different variants—which, in the absence of possibilities of comparison, cannot be discerned—and we are forced to treat as significant whatever information the fossil has to offer. What is more, we are inevitably tempted to classify disparate fossils in broad categories or "families," as was the case for a long time with the Palaeoanthropians whom anthropologists persisted in grouping round the nucleus of the first Neanderthalians. Another aspect, one related not to physical conditions of documentation but to racial genetics, must be considered in connection with Neanthropian physical development. Genetic experiments with animals have given us an insight into certain aspects of racial and individual variation. Two factors play a preponderant role in the constitution of individual genetic formulas which, in combination with one another, establish the racial type: geographical isolation and population density.

To varying degrees the importance of the former factor depends on the latter. For example, the areas populated by the main racial groups (white, black, and yellow) are so obviously larger than those in which mixed characteristics may be found that each group is in effect isolated from the others, areas of crossbreeding forming only a narrow fringe at the borders. The full range of possible formulas can be found within each group. In the case of low-density groups, on the other hand, isolation plays a very important role in terms of genetic development. Any group composed of some thousands of individuals, if segregated or insularized, will in time tend to acquire the characteristics of a homogeneous race, which explains why all the "pure" races beloved of classical anthropology—Ainus, Bushmen, Lapps, Eskimos, Australian aborigines—are groups that experienced prolonged isolation in the course of which their genetic capital became standardized. These geographically marginal groups, like animal groups in similar circumstances, show very clearly defined characteristics, often of an aberrant nature, and their general structure often remains quasi-archaic. It is among such groups that the most clear-cut examples of survival of the original Neanthropian type are encountered.

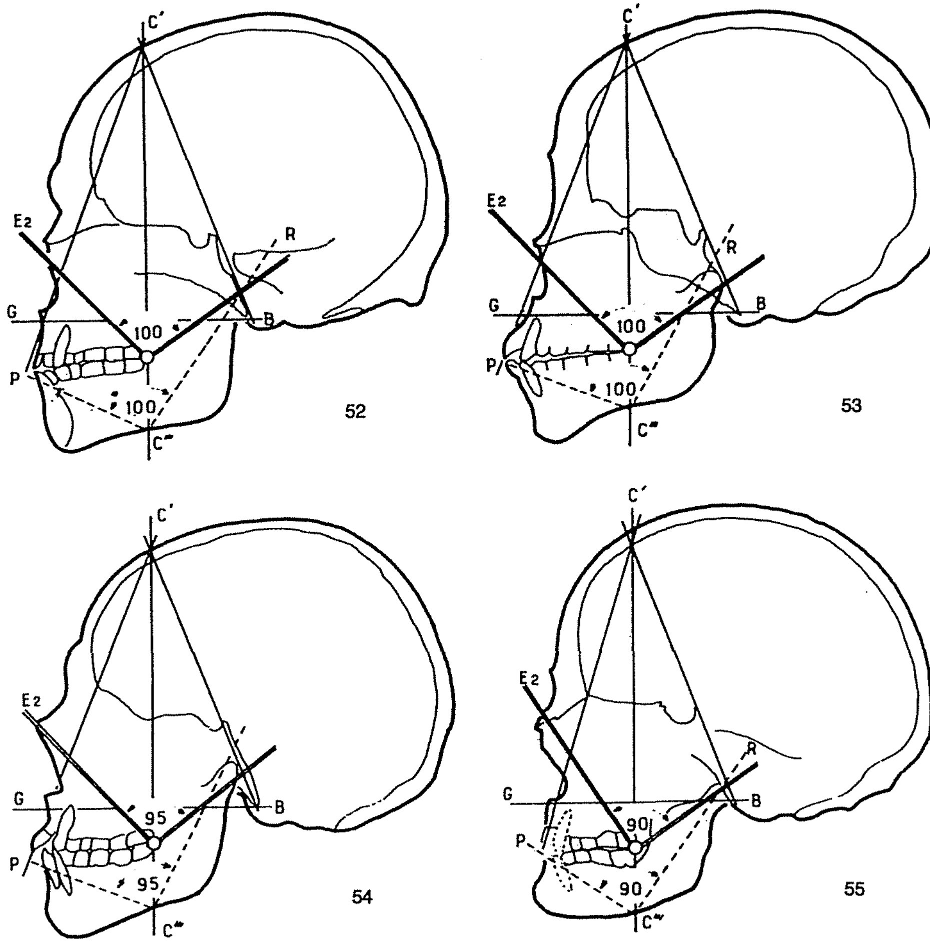
The density factor, when associated with an open geographical setting, plays a capital role in determining the general physiognomy of populations, whether it be in densely populated areas of restricted size (such as Europe, India, or the Far East) or in areas such as Africa where the mobility of individuals or groups offsets relatively low population density. In such groups it is very difficult to pinpoint a clear-cut racial type, genetic standardization being prevented by crossbreeding. The group, which may consist of several millions of individuals, develops as a whole and produces an ill-defined "average" type representing the balance struck between the individual variations. Since such populations include the fewest individuals of the archaic Neanthropian type, it would seem that this situation is the most conducive to an accelerated drift proceeding by distinct stages.

If we consider individuals of the most widely varying provenance representing the general movement which originated with the primitive Neanthropians, we find a new stage-type already much in evidence (figure 51). It occurs among whites as well as in the black and yellow races, among dolichocephalians as well as brachycephalians. Its chief characteristic is the harmonization of diameters, especially as regards the length and width of the face and skull. No increase in cerebral capacity is perceptible, but the face tends to become narrower and remains short. The orbits are proportionally large, and the absolute proportions of the nose—which is wide in the black races and narrow in others—remains relatively unchanged.

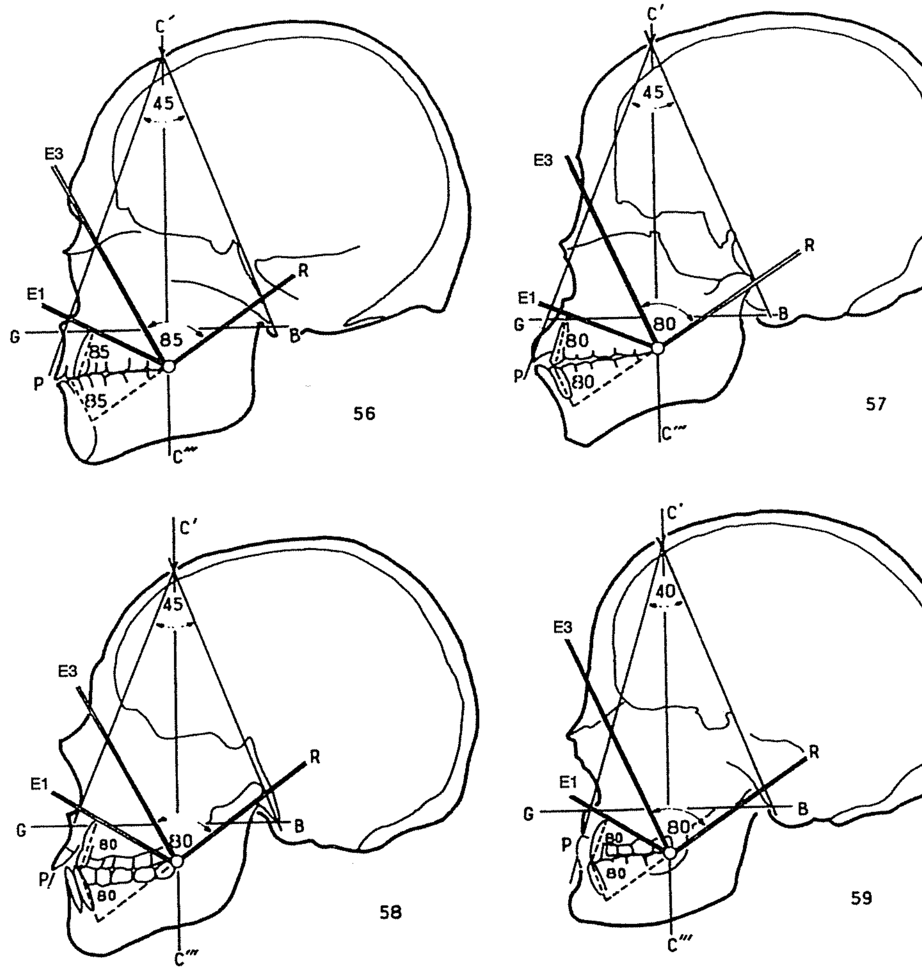
The phenomenon of reduction in the massiveness of the face that characterizes the earliest Neanthropians is thus maintained in all high-density groups as part of a process of standardization of facial width and height (figures 52 to 63). This phenomenon is connected with the general regression of the dentition, taking the form of reduction or complete disappearance of wisdom teeth and smallness of the roots of all teeth. It would be hazardous to relate the whole history of human cerebralization to a single mechanical cause—the reduction of the dentition, a genetic evolution concerning which our knowledge is still extremely incomplete—but dental evolution expresses better than any other factor the mechanism of a complex evolutive process that is still continuing in all modern humans.

Physical Stocktaking

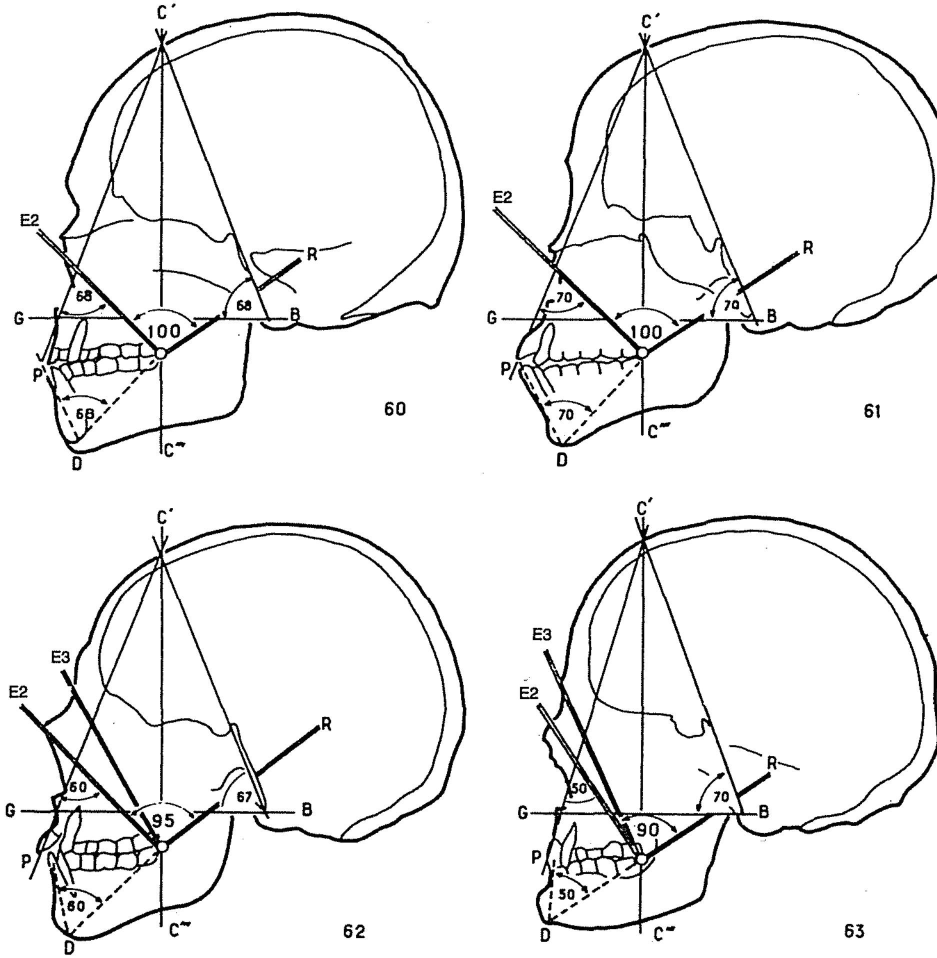
The physical development of *Homo sapiens* can be traced through various races over a period of some thirty thousand years. The diversity of racial types makes it difficult to establish the details of the process within so short a time frame, but chronological analysis does yield some useful facts. The earliest specimens, many of them associated with the "race of Cro-Magnon," exhibit a very distinctive cranial type: The brain box is large and very long, the face is wide and extraordinarily short, especially by comparison with the directly preceding Neanderthalians; the orbits are extremely low and rectangular. This type of cranial conformation is found in practically all Upper Paleolithic fossils in France, Central Europe, Germany, the U.S.S.R., and as far afield as China. This would seem to be the most archaic skull structure of our species. In Europe this type continued into the Mesolithic, with evidence being found in Portugal, Brittany, and Denmark. Individual instances of the same type of structure can still be found in all regions of the world today, but as a collective racial formula it applies only to Tasmanian and Australian aborigines and some New Caledonians.



52–55. Narrowing of the jugal "compasses" in Homo sapiens. *The angle decreases from 100 degrees in the New Caledonian (figure 52) and the Melano-African (figure 53) to 95 degrees in the European man with a complete tooth row (figure 54), and 90 degrees in the European woman with no back molars. Note the shift on the axis E2, as a result of which (figure 55) the support for the cheekbones tends to merge with the support for the forehead (loss of mechanical independence of the front teeth).*



56–59. Structure of the canine tooth row in Homo sapiens. *Same individuals as in figures 52 to 55. Note that the connection between the front teeth and the prefrontal bloc is maintained in the modern man. In the individual without back molars (figure 59), the angle C′ has narrowed to 40 degrees, reflecting the shortening of the base P–B; the line of support for the canines (E3) tends to merge with that for the molars E2 in figure 55.*



60–63. The general balance of the face is expressed by the fact that the angle of the cheekbone E2 equals the angles of the chin D and of the apophysis of the basion B, which links the facial structure with the stresses due to erect posture. Taking the New Caledonian (figure 60) and the Melano-African (figure 61) to represent the normal balance for Homo sapiens, *we note that the values of the cheekbones, the chin, and the base are identical. In the European (figure 62) the axis E2 has begun to shift toward E3, and the face (60 degrees) is not in balance with the base (figure 67). The disappearance of wisdom teeth (figure 63) reflects a real distortion of the skull in search of a cranial structure compatible with erect posture, a case of "superevolution" comparable to that of the Pomeranian (figure 24).*

After the Upper Paleolithic a considerable diversification of skull types took place. In many different races, especially in regions of high population density, certain traits that seem to carry on the anthropoid evolution appear often enough to be considered significant. The brain shows no marked tendency to increase in volume; indeed no gain would seem to have been achieved in this respect since the Neanderthalians. The facial dimensions, on the other hand, tend to diminish, and this decrease in facial volume is often reflected in the disappearance of wisdom teeth (figures 55, 59, and 63). The fact that the length of the dental arch has been reduced—the first molar continuing to provide the main point of support for the face—has made the forehead come increasingly to overhang the face. This was first noticed more than half a century ago and has been the source of theories to the effect that the modern human is a fetus or an infant arrested at an early stage of its development. It is a commonly observed fact, in monkeys as well as in humans, that the volume of the brain in childhood and adolescence is considerable by comparison with the size of the face, which does not assume its definitive proportions until puberty. Only a step was needed to conclude from this observation that evolution toward the human being was a kind of gradual prolongation of infantile states that supposedly gave the intelligence time to develop—and the step was readily taken. I myself prefer to think that we should no more regard the human as a fetus of a gorilla than we should cling to the idea of the ape-ancestor: Both are forms of the same morbid search for our monstrous twin. We have also seen that in *Zinjanthropus,* the formula of a human body with a human skull containing a small brain was proved mechanically sound. Is it conceivable that the rhinoceros is really a kind of latter-day fetus of the hyrax, or the trout an embryo coelacanth? By trying too hard to explain why our brain is larger than others, we may find ourselves denying an evolution that from the start has tended toward improved neural organization, and consequently toward an increase in the weight of the cerebral apparatus. Taking a general view of the body as a machine, the general mechanism of the human species has not undergone any fundamental change since the time of the first bipeds. Only successive modifications have occurred. In the Neanderthalians the balance of the face was still based upon the canines and the first molars; with *Homo sapiens* the canines ceased almost entirely to provide support and the prefrontal region was unbarred. None of this is remotely connected with the infantile stages of monkeys. *Zinjanthropus* has nothing in common with a monkey's fetus about him—and the processes involved in the development of our lineage up to and including the modern human are biologically normal and have nothing to do with "fetalization."

The Human of the Future

Can the trajectory of human development be extended further? In terms of its main characteristics—vertical posture, hand, tools, language—the system called "human" reached its ceiling possibly a million years ago. If we ask ourselves how humans can develop still further without losing any of their fundamental traits, our thoughts inevitably turn to intracranial. Our parieto-occipital apparatus was stabilized by erect posture a very long time ago, which means that our posture would have to change if anything new were to happen in that area. The cranial convexity also appears to be stabilized so far as its middle part is concerned; give or take a few variations, the cortical fan has opened out as wide as it will go. A last improvement was achieved in the prefrontal areas through the loss of the orbital visor, followed by the disappearance of wisdom teeth, a process that is still in its initial stages. Progress in this direction cannot be unlimited; we have to acknowledge that not a great deal of scope is left if we are to remain human beings in the physiological and mental sense accepted today. Late in the nineteenth century, writers of futuristic science fiction, impressed by the fetus theory, imagined our contemporaries of the late twentieth century as having an enormous brain, a tiny face, and a shriveled body. The picture is false because there is no reason for any appreciable increase of brain volume in less than several thousand years. We are still only thirty thousand years old, and a great deal more time must pass before the species drift becomes strongly perceptible. The most that may happen—if the weight of the brain is really such an important issue—is a relative increase in brain weight due to artificial selection. But what those early science fiction writers failed to see is that no change is possible without the loss of the hand, the teeth, and consequently of erect posture. An anodontic human race living in a prone position and using such forelimbs as it still possesses to push buttons is not completely inconceivable, and in certain works of science fiction we find "Martians" or "Venusians" who come close to this evolutive ideal. But have we the right to say that such beings would still qualify as human beings? Paleontology is not without examples of species reaching a state of balance which subsequent developments reveal to be permanent. Some of these species, like the sharks, achieve a certain immutable stability, while others suffer definitive extinction. It seems probable that *Homo sapiens* would fall into the latter category; were we ordinary mammals, the prognosis would have to be resolutely pessimistic. We can, however, comfort ourselves with the thought that we remain subject to the general species drift and may consequently enjoy a respite of some tens of thousands of years before becoming extinct; we might also imagine that, by a voluntary act, we will make use of genetic laws to suspend the course of our evolution, at least for some time. But in any case it is not obvious what further "liberations" we could achieve without, by so doing, being transformed into a different species.

The Evolution of the Neanthropian Brain

The last really spectacular episode of Anthropian evolution was, as we have seen, the disappearance of the prefrontal ridge. In line with the procedure we adopted in respect of the other hominids, we must therefore consider the effects of this important modification of cranial structure upon the functioning of the brain. Brain volume remained constant from the time of the most developed Palaeoanthropians (Archanthropians 600–1,200 cubic centimeters, early Palaeoanthropians 1,200–1,300 cubic centimeters, Neanderthalians 1,400–1,600 cubic centimeters, Neanthropians 1,400–1,550 cubic centimeters), which means that major changes had to result, not from input of new matter, but from changes in proportions between different parts of the brain. An increase in cell density and in the number of connections probably occurred and the available volume was probably utilized more efficiently, but there is no way of checking these hypotheses by paleohistological means. The essential factor, however, would seem to have been the development of the prefrontal part of the brain. A relationship between forehead size and intelligence was established empirically a very long time ago and assumed the status of scientific truth, almost of dogma, with the works of late eighteenth century authors, particularly Louis Daubenton and Pieter Camper. But before we accept this idea, which has become a commonplace, and develop it further, we should recall that brain volume, intelligence, and the development of the forehead are not necessarily interrelated. Individual exceptions to the statistical mean are very numerous, and it has long been known that a brain that is small in size but compact and finely organized, even behind a low forehead, is preferable to a bulky one. There is, however, a statistical truth in which the very essence of anthropoid cerebral evolution is contained, namely humanity's gain of the whole of the prefrontal areas.

Over the past few decades neurophysiology and neurosurgery have extensively explored that region of the brain that is divided into two zones: the neocortex, which is located in front of the premotor areas, and the rhinencephalon, which is a very ancient part of vertebrate brain structure. The rhinencephalon, whose main role since the lower vertebrates has been to interpret olfactory data, underwent considerable change in the higher mammals, becoming one of the mechanisms that regulates the emotions. It is, we could say, the center of affective integration in the cerebral apparatus. As for the prefrontal cortex, numerous surgical experiments and observations confirm that it constitutes one of the principal elements of individual personality, and most neurologists believe that it plays a predominant role in controlling operations and in the powers of foresight and lucid consciousness. The development of the rhinencephalon at the upper end of the animal scale and its proximity to the controlling cortex provide at least a partial insight into what the disappearance of the prefrontal bar did for the evolution of the human. By virtue of its prefrontal regulatory apparatus, the forebrain of *Homo sapiens* stands between the technical motor function cortex and the emotion-triggering cortex. Prefrontal lobotomies, which for some years were practiced in the treatment of certain categories of mental patients, brought out the dual suppressing and stimulating role played by the prefrontal cortex in affective and motor processes. It would be impossible to imagine an apparatus better designed to serve the intelligence than one that governs emotional impulses and motor organization at the same time. Although not yet fully investigated, the role of the prefrontal cortex as an instrument of affective regulation, operational control, and intellectual judgment appears essential. Before affective regulation was achieved, there could be no question of intelligence or thought in the fully human sense. What is more, we shall see that in the history of human societies the disappearance of the frontal bar was rapidly followed by profound changes in the relationship between humans and the biological world. Some development of the prefrontal areas may no doubt have occurred even in the most primitive Anthropians, for the emergence of tools and the development of operating sequences on the basis of motor and premotor mechanisms alone is inconceivable. Already with *Zinjanthropus* a frontal brain was interposed between the emotions and the motor reactions of *making*—of technical organization—and its role even then was surely very important. Yet it is strikingly true that the frontal region becomes steadily larger with the passing of time and with increasing evidence of a controlling intelligence. In accepting the postulate that in the case of the Australanthropians and Archanthropians, the development of techniques more or less kept pace with that of the skull, we allowed for the possibility of individual creative intelligence manifesting itself even at that early stage. In linking technical progress at that level with biological development we are, I believe, merely acknowledging a phenomenon comparable to that which, in *Homo sapiens,* links technical progress to the organization of the social group. The fact that emerges most clearly, once the freeing of the forebrain has taken place, is the importance assumed by the social group as opposed to the zoological species. As soon as individual variations begin to play a preponderant role in progress, the register of values also changes. Very palpably it was during the time of the Palaeoanthropians that this development took place. In terms of form they still belonged to a world whose imperative values were zoological—a world that had not yet fully mastered the possibilities of technics and language, though certain important details show them as already forming part of the world of today. Study of their culture, too often neglected by scholars more interested in finding skulls than in understanding the human being, is fundamental to our knowledge of ourselves, for when all is said and done it was in the Palaeoanthropians, and not in the Australanthropians, that the penultimate act of our history was played out.

Diversification and Tempo of Technical Evolution

Now that we have established a certain number of facts about the physical nature of our ancestors and about their intelligence, we should give some consideration to the history of their techniques before we turn our whole attention to *Homo sapiens*. In briefly reviewing the main stages of that history, I shall endeavor to pinpoint the connections between material and biological progress in the early parts of the process.

The Stages of Technical Evolution

Our knowledge of anthropoid technical development from earliest times until the beginning of the present climatic period is based essentially on tools made of knapped stone. Provided we recognize that such tools represent only a very small part of the fossil human's equipment—for anything made of a substance more perishable than flint must remain unknown to us for practical reasons—we may regard their testimony as pertinent.

Nineteenth-century tradition, still obeyed by too many popularizers today, created a picture of prehistoric man by simply substituting ancient elements for modern ones: three-piece suit = bearskin wrapped round the waist, woodcutter's ax = biface tied to the end of a stick, house = cave, and so on. Illustrations of every kind, from frescoes on lecture-room walls to films and comics, have familiarized us with this picture, which is not even based on the primitive races living today but simply presents prehistoric man as a more rudimentary version of the man of today. Comparisons with the Australian aborigine or the Eskimo can help the researcher to some extent, but objects now available to these peoples are so numerous and so highly specialized that the parallel should not be pursued too far. In fact our picture of prehistoric man as a technical being remains one of extreme poverty, and this applies almost equally to *Zinjanthropus,* whose technical culture was no doubt really very meager, and to fossil *Homo sapiens,* who left only some stones and a few pieces of carved bone behind him, but whose equipment must in fact have been considerable.

Yet, if we look at the details, we find that the amount of documentary evidence about *Homo sapiens* for the period between 30,000 and 8000 B.C. is fairly substantial. Without attempting too rigorous a cultural identification, we could say that humans built huts and made tents, that their clothing consisted of finely sewn skins, and that they adorned their bodies with necklaces and latticework ornaments made of animal teeth, shells, or pieces of carved bone. We know that they used spears for hunting and were experienced butchers and furriers. As artisans they had a wide variety of tools at their disposal, including tools for the rough working of flint as well as for very fine bone carving. Add to this some other crafts, such as basketry, bark work, and woodwork which prehistoric humans had probably mastered, and we obtain a rather rich picture that could serve as the pattern for a multitude of primitive cultures, both dead and living.

If we attempt the same synthesis for the most recent Palaeoanthropians, about whom the Mousterian in Europe supplies substantial evidence, the picture is consistent but considerably poorer. The highly evolved Palaeoanthropians knew how to erect shelters (huts or tents), they probably hunted with the spear, and there is ample evidence of their skill in skinning and cutting up animals. The range of their manufacturing tools was limited; they did not work in bone, but we have reason to suppose that they did work in wood and bark.

To go further than that would not be reasonable. No excavations seriously angled on cultural research have been conducted for early Palaeoanthropians or Archanthropians, who are very rarely found in their habitat. A path of technical evolution stretching back from *Homo sapiens* to the Australanthropians is perceptible, but it runs too close to the line of gradual disappearance of records to be interpreted with any degree of certainty. What hope we have of building up a picture of technical evolution must therefore rely exclusively on the stone industry.

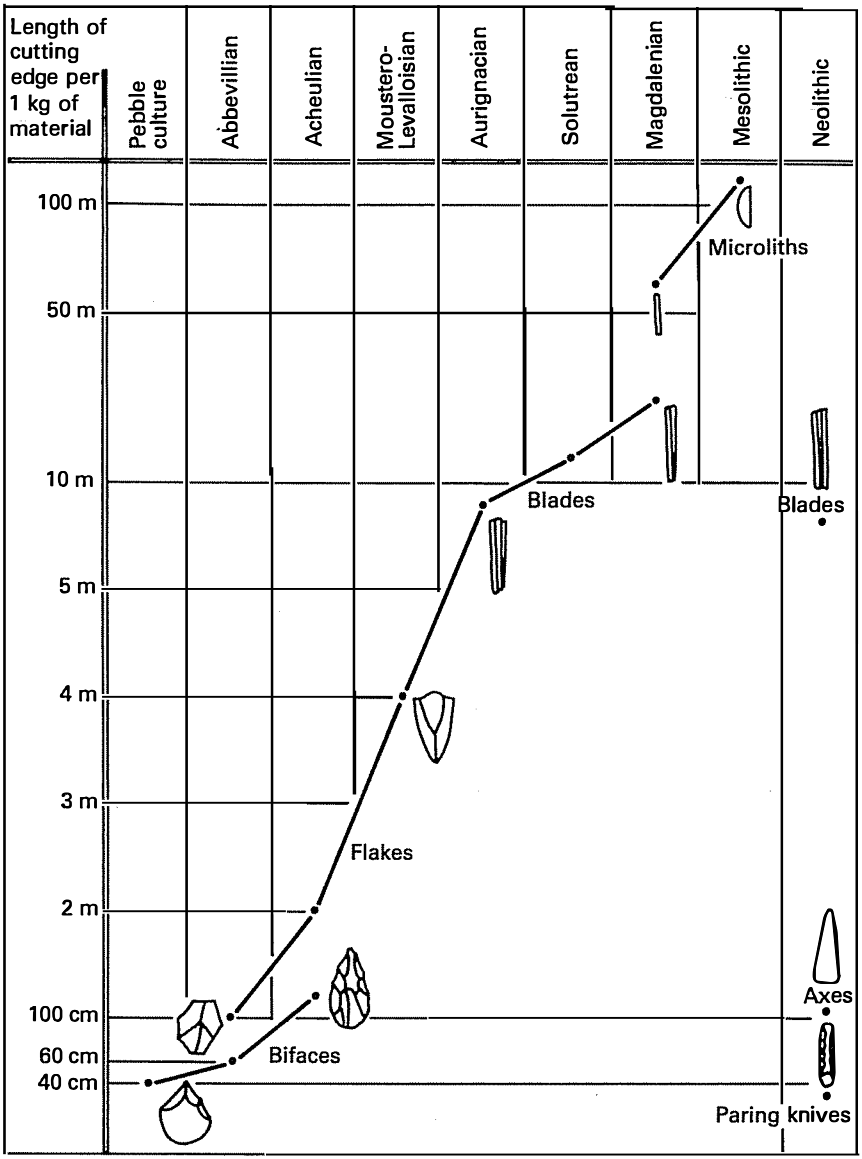
The Stone Industry

Leaving out of account the stones used for striking and the faceted spheroids whose purpose remains enigmatic, we could say that all stone tools were intended for cutting, scraping, or piercing. In trying to trace our technical evolution with the help of knapped-stone tools, we therefore depend on a cultural image strictly limited to sharp objects. We need only imagine any present-day culture from which all forms of equipment other than sharp-edged tools or weapons have been excluded in order to gauge the inadequacy of our knowledge of the industry of the fossil human. Once we have grasped this fundamental fact about the nature of the available records, we can concentrate on those factors from which a picture of technical evolution may nevertheless be derived.

European prehistorians discovered long ago, by empirical means, that the average size of flint tools decreased from the Abbevillian to the Mesolithic. Large bifaces were gradually replaced by Mousterian flakes and later by the blades characteristic of the Upper Paleolithic, which in turn led on to Mesolithic "microliths." It occurred to me some years ago that this development, resembling as it does certain evolutive processes observed in paleontology, might reflect a general technical fact that has nothing to do with the form of tools but represents something in the nature of an "orthogenesis." My initial hypothesis was that the process of extraction of a cutting edge from a lump of flint varied in time proportionally with the ratio between the length of cutting edge obtained and the volume of flint required to obtain it (figure 64).

The hypothesis can easily be verified by experimental means. All that needs to be done, leaving discards out of account, is to determine the length of usable cutting edge per kilogram of flint fashioned into tools of a specific form. Figure 64 shows the remarkable progression of this ratio, which reflects the first material relationship between humans and minerals. It is fascinating to find that this relationship developed strictly in parallel with human evolution, a fact that confers a curiously biological character upon the prehistory of sharp-edged objects. The parallel becomes still more obvious when we consider the succession of forms in greater detail.

From Chopper to Biface A rough-cutting edge formed by perpendicular impacts upon the edge of a pebble is a "chopper," a "core tool," the prototype of a long series. The initial operation led on to a second one whereby a few additional splinters were chipped from either side of the pebble in order to produce a point. The cutting edge was now exposed more conveniently for use. The very crude tool thus obtained is a biface—a heavy, almond-shaped cutting tool that evolved slowly over a period of around four hundred thousand years. In the Acheulian the cutting edge originally obtained by a series of identical perpendicular strokes (60 centimeters) assumes a more regular and more slender form (1.20 meters) as a result of tangential impacts applied in order to produce the first long flakes. At the peak of its



64. The relative lengths of usable cutting edge obtained from a kilogram of flint at different periods of the Paleolithic.

evolution, the biface was an almond-shaped piece of flint, thick but well balanced, although having an asymmetric cross section because of the two distinct series of actions involved in making it. To produce the biface, long, regularly shaped flakes (which in turn were employed as knives) were removed by chipping from both ends of the initial lump of stone.

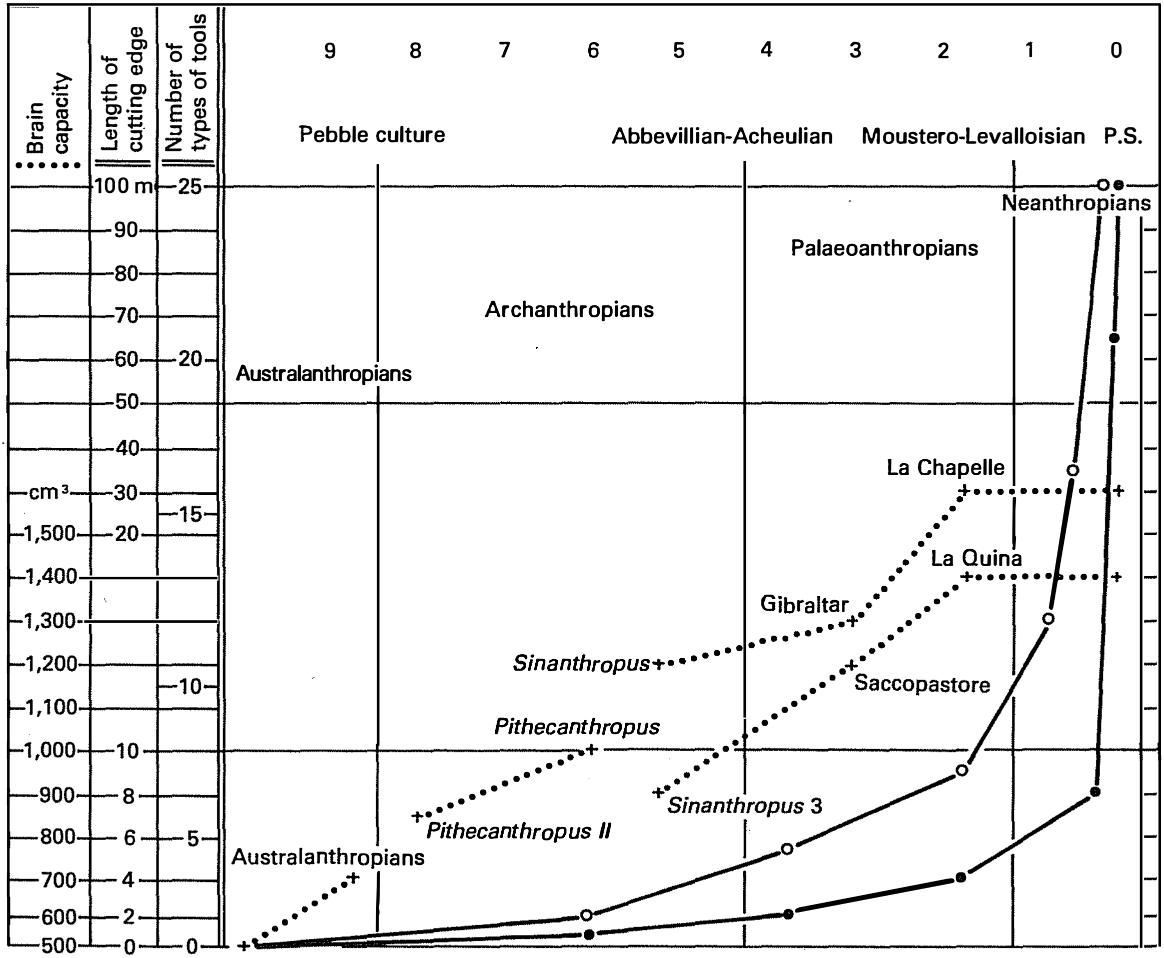
From Biface to Levalloisian Point The biface had now become the source from which flakes were obtained. Instead of being a "core tool," it was itself treated as a core. The asymmetry of its cross section was more accentuated, and it was gradually turning into a mallet used to produce flakes of predetermined shape. A change of function had taken place as a result of the adaptation process, and during the hundred thousand years or so of the Levalloiso-Mousterian period the stereotyped core was used to produce three or four types of flakes—oval, elongated, and triangular. The technique's development culminated in the production of points with a thinner base, which could be as much as 20 centimeters long. The technical advantage was twice that obtained with the biface because the same amount of flint yielded three times the length of useful cutting edge and because even quite small lumps of flint could be put to use. As a result the toolmaker was no longer obliged to work in the immediate proximity of places where unprocessed flint was to be found.

From the Levalloisian Point to the Microlith In developing the core as a source of flakes of predetermined shape, the Mousterians achieved what was perhaps the most important technical revolution in the whole of human history, the subsequent evolution involving only minor improvements of the flake-forming technique. The improved angle of impact meant that a longer core was obtained, which in turn offered the possibility of producing increasingly narrow and slender blades. Progress during the Upper Paleolithic consisted in developing such blades into tools of various forms. Moreover every sizable piece of discarded material found a specific use depending on its shape, so that from the Gravettian onward, about 25,000 B.C., wastage was reduced to practically nil. Toward 12,000 B.C., in the Magdalenian period, the range of tools was already so wide that several hundred tools could be produced from only two or three kilograms of flint. This explains why flint objects have been found in dwellings of the period hundreds of miles from any natural source of raw material. Toward the end of the Magdalenian and in the Mesolithic, between 8000 and 6000 B.C., the trend toward the production of microliths became accentuated, and a further stage entered the technical process: Blades obtained from the core began to be cut up into small sections of geometric shape, so the blade in turn became a source of products.

In the Neolithic era the general tradition persisted, but the ratio between mass and cutting-edge length changed dramatically, falling to extremely low figures. The reason for this was that technical requirements were being completely transformed by agriculture: A hatchet or an adze has only a narrow cutting edge but needs to be rather heavy. For flint knives, however, the ratio continued to be closer to that observed in the Upper Paleolithic (between 6 and 8 meters). At the dawn of the age of metallurgy, toward 2000 B.C., imitations of Paleolithic copper daggers—which could be over 30 centimeters long—were still being made at Grand Pressigny in France from a huge core prepared in the old traditional way.

Thus the art of making cutting blades, from the earliest choppers to the long blades of Grand Pressigny, followed an unbroken line of evolution leading gradually, irrespective of form, toward better adaptation of the material to the desired purpose. Some things about the geochronology of the Quaternary are still uncertain, but although the geologists' estimates vary widely—between half a million and one million years—the general proportions are more or less universally agreed upon, and from 100,000 B.C. onward the views held are practically unanimous. In figure 65 the chronological development of the cutting-edge–weight ratio is compared with the brain volume of a number of anthropoid fossils.

The comparison—which might seem artificial because it is drawn between biological data, on the one hand, and a phenomenon relating to technical progress, on the other—is nevertheless highly revealing. Up to and including the Archanthropians, the two curves follow parallel courses and are almost flat; they then rise steeply during the Moustero-Levalloisian period, which saw the development of the early Palaeoanthropians, after which the "industry" curve rises vertically while those representing brain volume flatten out and remain flat until the present day. This tends to confirm the tentative finding of our last chapter, namely, that the very slow opening out of the cortical fan, probably quite closely reflected in cranial capacity, continued little by little until the Palaeoanthropians, in whom a radical biological crisis occurred and was resolved with the disappearance of the prefrontal bar. Until then technical activity was a faithful reflection of biological status; had the human continued to be other than *Homo sapiens,* the industry curve might have been expected to start rising between 200,000 and 400,000, years *after* our era, instead of in the Magdalenian, 10,000 years *before* it. In other words, it does seem as though the "prefrontal event" had marked a radical turning point in our biological evolution as a zoological species governed by the normal laws of species behavior. In *Homo*



65. The relationship between increase in brain volume and technical evolution during the Quaternary period of the Cenozoic era (relative length of blade per kilogram of material and diversity of tool types).

sapiens technicity is no longer geared to cell development but seems to exteriorize itself completely—to lead, as it were, a life of its own. Different aspects of this separation will be considered in subsequent chapters.

Diversification of Products

A clear confirmation of this conclusion is obtained if we draw up a list of successive extensions of the range of tools and correlate it with stages in the evolution of rough-cutting methods. Figure 66 surveys the evolution toward special-function tools and brings out the importance of the bone industry and of products other than those required for simple subsistence in the last (fourth) stage.

A striking feature of the figure is that development in the first three stages takes place uniquely by the addition of new forms derived from still existing older ones. A single current flows through all the industries, from the pebble culture to Mousterian, confirming what we know of the consistent biological evolution of humans from Australanthropians to Neanderthal man. But the third stage is already set upon a new course and Neanderthal man already displays some of the distinctive features of the next stage. Not until the final part of his long reign, however, did he begin to manufacture bone awls which were, properly speaking, fashioned.

The fourth stage is in complete contrast to the earlier ones. At the end of a rapid transitional phase which occurred in Western Europe between 35,000 and 30,000 B.C., we not only find that the diversity of tools has tripled but also that some tools and other objects seem to be directly echoed in present-day primitive culture. Blade tools, scraping and piercing tools, needles, spears, harpoons, spear and harpoon throwers, and lamps belonging to that period have been seen and can still be seen in the hands of living people. A new technical world, our own world, is coming into existence.

The stone industry of the fourth stage (Upper Paleolithic) is firmly rooted in the preceding stages and the evolution of new forms from older ones, though rapid, is gradual. The two curves—cutting-edge–weight ratio and diversification of forms—rise vertically between the end of the Mousterian and the Magdalenian, but this can be seen as an acceleration rather than a fundamental change. The situation is altogether different in the case of the bone industry, which was literally born at the approaches to the late Paleolithic.

We have already referred to the existence of a bone industry during the earlier stages, but the bone splinters attributed to the Australopicinae, the Sinanthropians, or the Alpine Mousterians hardly deserve to be described as an industry. The most

	First stage	Second stage	Third stage	Fourth stage
Stone	Perpendicular striking Core tool	Perpendicular striking Tangential striking Core tool	Perpendicular striking Tangential striking Prepared core Flake tool	Perpendicular striking Tangential striking Prepared core Flake tool Blade tool
	Chopper Clactonian flake	Chopper Biface Clactonian flake Laminar flake Hatchet Scraper	Chopper Biface Clactonian flake Laminar flake Levallois flake Hatchet Scraper Levalloisian point Notching tool Backed blade Scraper	Laminar flake Backed blade Notching blade Foliaceous point Notched point Geometrical objects Notcher Scraper Burin Piercing tool
Bony materials			Graver awl	Awl Needle Spear Harpoon Spear or harpoon thrower Piercing tool Spatula Semispherical rod Wedge Pick
Miscellaneous	Polyhedrons	Polyhedrons?	Polyhedrons Dyes Fossils Huts Burial places	Dyes Fossils Ornaments Lamp Huts Burial places Figurative art

66. The diversification of tool types in the Paleolithic.

that can be supposed—although the fact is far from proved—is that from among pieces of bone they had splintered in order to extract their marrow, these anthropoids selected some that could be put to direct use. The only incontrovertible evidence consists of a few deer antlers roughly cut into segments; not until the end of the Mousterian do bone awls—extremely rare and few in number, but carved with remarkable skill—make an appearance.

This absence is very curious and could be due to very significant facts pertaining to general behavior. On the face of it, there seems to be no possible reason why the Archanthropians and Palaeoanthropians, excellent artisans capable of visualizing the future shape of their bifaces and points in a lump of raw stone, should not have been able similarly to "read" an awl, a gimlet, or a spear in a bony mass. What is more, their stone tools as well as certain other material evidence suggest that they used spears and lances made of wood. A no less singular fact is that bone tools appear contemporaneously with objects of adornment made of similar materials—spikes and spears on a par with bone ear pendants or animal teeth prepared for use as ornaments. Although we, with our brain of *Homo sapiens,* cannot quite grasp why this should be so, chipping a tool out of flint or rasping down a wooden pole in order to make a spear are operations on a different level from the slow process of fashioning a spear from a mammoth's tusk. We can argue that the need for an awl or for a more pointed lance did not arise until the end of the Mousterian, but by doing so, we posit the existence of concerns and technical means which were probably altogether beyond the early anthropoids. Instead of insisting—for reasons that would presuppose that their mind ran along the same lines as ours—that they must have had a bone industry, we could simply say that they had not yet reached the point at which these techniques were to emerge.

Diversification of Ethnic Groups

The only way in which we can try to understand the human phenomenon in its totality is by carrying out a series of verifications of many aspects of the initial hypotheses. For the present it appears that a very profound change took place with the disappearance of the prefrontal bar, when the steadily rising curves representing industrial progress and the increase in brain volume, respectively, began to diverge in a spectacular manner; brain volume had apparently reached its peak and the industry curve, on the contrary, was at the start of its vertical ascent. We may assume that it was at this point that, from being governed by biological rhythms, human cultural development began to be dominated by social phenomena.

Is tentative verification of this hypothesis feasible? Ideally the vestiges of prehistoric times should provide us with at least one criterion for ethnic differentiation, given that the idea of the dominance of social phenomena presupposes that humans were beginning to combine in groups of cultural affinity rather than in social groupings similar to those in existence among the most evolved vertebrates. In the living world such criteria are not hard to find; language is the most convenient one, but social and religious customs and aesthetic traditions also offer means of drawing ethnic frontiers within human populations. None of these criteria is unfortunately available to the prehistorian. Art came upon the scene too late to be of use as a means of differentiation at the level at which the argument of these early chapters is conducted. Technology offers the only hope. But the results of trying to check the validity of technical criteria against the ethnic divisions of the living world of today are somewhat disappointing. True, there are the minutiae that enable us to distinguish a Danish sickle from an Austrian, Spanish, or Turkish one, but if we were considering those objects across a distance of several thousands of years, and if they had moreover lost their handles, can we be sure that they would still reflect cultural distinctions as marked as those which we know exist between Danes, Austrians, Spaniards, and Turks? The prehistoric records we have are not a satisfactory source for research of this kind. Yet it has to be admitted that, poor witnesses of ethnic diversity though they are, only tools even suggest the existence of such diversity. Implicitly prehistorians have always been haunted by the problem of how to differentiate between ethnic groups. Influences unconsciously absorbed from history, where everything happens between peoples, put them in the habit of regarding Acheulians, Aurignacians, Perigordians, and others as real ethnic entities, and sometimes as both ethnic and anthropological entities. This attitude is particularly evident when it crystallizes around certain striking and readily recognizable objects such as "Solutrean bay leaves." All too easily the Solutreans then become a people or even a race, cropping up all over Europe and the world at the behest of successive studies and excavations. Yet the Solutrean (to pursue the same example) is not a person but a certain manner of making an object. Even more narrowly, it is a style of fashioning flint applied to an object that in all probability was the reproduction in stone of a spear tip made of bone. Stripped of all but its essential content, the Solutrean fact belongs entirely to the field of ideas: One day when prehistory has advanced further, it will no doubt be possible to trace the progression of the Solutrean idea across the Europe of around 15,000 B.C. just as it is possible today to map the distribution of television sets across the rural areas of Western Europe. This example shows how futile it is to look for clues to the intimate personality of ethnic groups in objects that became associated with an epoch because of their dramatically innovative nature. That being established, it remains for prehistorians to try, not to delimit ethnic groups with the help of prehistoric tools, but to see whether there is anything in such tools and other objects that does suggest ethnic diversification. In other words, the cartography of the main types of tools, and especially of different versions of these main types, should furnish some useful hints. At the present stage of knowledge the task can only be performed in very broad outline, but even so the approach offers some valuable information. Available records of the first (pebble culture) stage show no differences throughout the whole African continent except in the nature of the stone used. Given that only the chopper and the Clactonian flake tool are at present recognized as belonging to the first stage, the existence of any variants hardly seems possible.

In the second stage, despite enormous gaps in the records, we can assume the existence of several large industries with the emphasis at times on the biface, at others on the Clactonian flake tool, or on large flakes produced by tangential impacts. These forms recur in varying proportions over very large geographical areas (Indonesia, Asia, India, Central Europe, the Mediterranean, Africa), revealing—if nothing else—the existence of what we might be tempted to describe as "civilizations" if the term were not connected exclusively with the emergence of cities. In any case we are entitled to believe that very large culturally homogeneous areas existed in the Lower Paleolithic. Since everything suggests that no variants (other than those due to the nature of the raw material) existed within those cultural areas, we can consider that differentiation at this stage was not yet of a different order from that observed in zoological subgroups, especially since distribution was severely limited by climate and the irregularities of continental configuration. The existence of genuine small-sized cultural entities in Europe and Africa during the Abbevillian and the Acheulian would be difficult to prove. If we had means of knowing Acheulian languages, we might be surprised to discover a multitude of dialects, but such materials as we do possess force us to acknowledge that exactly the same technique was employed in making a Saharan biface as in making a biface found on the banks of the Somme.

The situation is not very different in the third stage, which includes the whole Levalloiso-Mousterian industry. The number of forms remains small and variants are rare. If we consider the best-known area, that of Europe and Africa north of the equator, the only striking example of a regional variant is provided by the hafted tools of the Aterian tradition. It is not impossible, however, that a thorough study of, say, the industries of Eastern Europe might show that the fragmentation of large cultural areas was more marked in the middle than in the Lower Paleolithic.

In the fourth stage the situation changes completely. Forms such as the Aurignacian split-hafted spear or the Solutrean awl do still recur throughout the European continent, but the effects of regional differences are already clearly perceptible in the range of tools as a whole. The imperfect state of present knowledge makes it impossible to draw a map showing the situation—even in Europe alone—for every period of a thousand years, but what we do know is that although the biface remained unchanged for several hundreds of thousands of years from Great Britain to Southern Africa, more than two hundred variants of the twenty main types of tools existed in Western Europe alone during the twenty thousand years of the Upper Paleolithic. It might be thought that such a wealth of variations was not necessarily due to ethnic diversity but rather to the same acceleration as we observed when considering the ratio between the length of cutting edges and the volume of raw material employed to produce them. But to think this would be, as it were, to put the cart before the horse, for, as we shall see in the next chapters, cultural diversification has been the main regulating factor in the development of *Homo sapiens*. Although, as has been said, tools are in many ways an unsatisfactory criterion, art—examples of which are available from the Upper Paleolithic onward—indisputably shows the existence of distinct regional entities living side by side and steeped in the same material culture but separated from one another by the myriad details of their group personalities.

5 The Social Organism

The Biology of Societies

So far we have considered the human being as a *phylum,* that is, as a time sequence of collective individuals eventually culminating in *Homo sapiens.* The evolution of these specific individuals (*Australanthropus, Archanthropus, Palaeoanthropus*) proceeded side by side with that of technics and language until the emergence of *Homo sapiens.* At that point a change occurred in the tempo of technical development, a change apparently due to a major modification of the cerebral apparatus. As we are now beginning to realize, these developments coincided with the emergence of a social apparatus based on cultural values. As a result of that the zoological human species broke up into ethnic groups, and relationships of a new type began to form between the individual and the group mechanism from which the individual derived his or her efficacy. Were we to infer from this that social life began with *Homo sapiens,* we would be mistaken. There is more than one reason to suppose that even in their most primitive form, anthropoids were already social beings. This can be demonstrated without invoking anthropoid apes and their various forms of organized social life. Instances of groups being formed for mutual benefit among mammals and other vertebrates, indeed throughout the living world, are sufficiently numerous to convince us that life in society reflects a basic biological option, like the option for bilateral or radial symmetry or like the specialization of the forelimb for grasping.

The relationship between individual and societal values in humans varies in direct proportion with the evolution of technoeconomic structures. We must therefore define these structures if we wish to understand certain properties of the social body at different stages of its development. The most direct effect of the technical level upon the social group involves the group's density. From the moment when, as a result of developments in the human intellect, values peculiar to *Homo sapiens* first came into being, the "technical level–social density" ratio became the chief factor of progress. In chapter 13 we shall discuss the use of symbols as a means of taking control of the outside world and will describe the gradual establishment of a completely humanized universe. At the present stage we need consider only the terms of the human's material relationship with the environment and thus to trace the main stages of our technical and economic development.

Analysis of techniques shows that their behavior over time resembles that of living species, as though driven by an apparently inherent evolutionary force that places them outside human control. The idea of "humans outstripped by their technology" is a commonplace and undoubtedly a mistaken one, but it would be just as erroneous to ignore the curious parallel between paleontology and technical evolution, a fact to which I have already drawn attention (particularly in *Milieu et techniques,* pp. 357–361). There is room for a real "biology" of technics in which the social body would be considered as an organism independent of the zoological one—an organism animated by humans but so full of unforeseeable effects that its intimate structure is completely beyond the means of inquiry applied to individuals. Is this enormously complex social body the result of a gradual evolution comparable to, and synchronous with, that of the brain, or was the form of the societies of today, a form that evolved within the space of less than ten thousand years, determined by other, nonbiological factors? A brief review of societies over the ages could help to answer this question.

In adopting the history of the brain and the hand as the subject of the first part of this book, I wanted to begin at the beginning. Humans are perceptible above all in their corporeal reality, and it seemed to me that the first thing to do was to measure the results of what can be done with the hand—to see what it was that humans make in exercise of what their brains can think. The approach involves some risk of ignoring or underestimating the incorporeal elements in human reality. To say that the human brain—in other words, human thought—could not have come into being without erect posture is to ignore the fact that "human" erect posture could not have been achieved without the general tendency of the central nervous system to progress by adaptation. Obviously the human being is the result of the coincident development of posture and of the nervous system; the attainment of humanity appears to have been a genuinely paleontological process which, in a Teilhardian perspective, may have been determined by the slow emergence of reflective thought through the geological ages. But whereas there is material proof for the first half of the proposition, only metaphysical evidence can be advanced in support of the view that evolution may, at some stage, have been guided by thought—a view that shifts the discussion to a level for which the paleontological method is but imperfectly suited. Exactly the same happens when we try to move from the paleontological sphere to that of ethnology. We can prove that the way in which material, technical, and economic factors are balanced influences social forms and therefore a society's thinking, but we cannot establish the principle that philosophical or religious thought coincides with a society's material development. Were that to be true, the teachings of Plato or Confucius would seem to us as archaic as a plow of the first millennium before our era. In fact, although we may think these teachings inappropriate to present-day social conditions as created by the evolution of material means, they do embody concepts that are still meaningful today. The equivalence of human thought is a fact that applies both in time and in space. Except in so far as it impinges on a purely technical field, or has a specific historical context, the thinking of an African or a citizen of ancient Gaul is completely equivalent to mine. That is not to say that each of our ways of thinking does not have its peculiarities, but only that once their reference system is known, their values become transparent. This fact is of an order that cannot be transposed to the material world, just as material proof cannot be provided for the hypothesis that the brain contributed toward the expansion of the skull. Each sphere draws upon its own source of evidence: For the material sphere that source is techology, economics, and history; for the sphere of thought it is moral or metaphysical philosophy. We may think them mutually complementary, but their complementarity is really a matter of mutual opposition.

Technical, Economic, Social

The close interdependence between social institutions and the technical and economic apparatus is borne out by countless facts. Although the nature of moral problems remains essentially unchanged, each society molds its behavior using such implements as the material world will offer. Social security for the mammoth-hunter is as unthinkable as is a patriarchal family in an industrial city. Technoeconomic determinism is a reality whose effect upon the life of societies is deep enough to bring into existence structural laws to govern the material world as firmly as moral laws govern the behavior of individuals toward themselves and their fellow beings. We may recognize that thought has as much reality as the material world, we may even assert that the latter owes its being to the effects of the former, but the fact remains that thought is reflected in organized matter. It is the organization of matter that, in various ways, directly shapes all aspects of human life.

Further along in this book an analysis of the rhythms and the organization of human society in space and time will help us to define more clearly the close connection between social behavior and the technoeconomic apparatus and to place both in a dialectic comparable to that which governs the relationship between the body and the mind as sustained by the nervous system. Difficult as it is to analyze a living substance—and humankind is precisely that—our study must begin with the technoeconomic skeleton of humanity. It was in this spirit that my book *L'Homme et la matière* was written twenty years ago.

Since Rousseau there has been no shortage of works on the behavior of "primitive" man. Those written in the eighteenth and nineteenth centuries were deliberately angled to give support to theories of political sociology. Their object was not so much to observe Australian aborigines or Fuegians as to plot a theoretical curve of social institutions, show how western society had deviated from that curve, and suggest ways of ensuring the social welfare of future generations. Marxism was born during this initial phase and has never completely outgrown it. The sociology of political action borrows from observation only those things it needs for purposes of practical demonstration. When a sociology of primitive peoples began to come into being toward the end of the nineteenth century, it derived its momentum directly from the general sociological movement then taking place. In France, Émile Durkheim, Marcel Mauss, and Lucien Lévy-Bruhl based their theoretical constructs of elementary social behavior upon indirect observations of living primitive peoples. Today Claude Lévi-Strauss and his school are trying, on the basis of social anthropology, to revive this approach within a perspective based on the exact sciences. Developments elsewhere have taken much the same course. Except for the Russian school of historians of material culture, the technoeconomic infrastructure has been taken into consideration only where its effect upon the superstructure of matrimonial practices and rites was blatantly obvious. Our best sociologists have certainly had things to say about the ongoing relationship between the two facets of human existence, but they have always said them in terms of the social sphere affecting the material one rather than of a two-way flow springing initially from the world of matter. The result has been that today we know more about people exchanging goods for reasons of prestige than about the kinds of exchanges that go on every day, more about ritual observances than ordinary services, more about the circulation of dowry money than about selling vegetables, and much more about how societies think than about how they are structured.

In making this point, I do not in any sense mean to disparage sociology or social anthropology, but only to observe that when Durkheim and Mauss so eagerly championed the "total social fact," they were assuming that the technical and social infrastructure was already known. Within such a perspective all material life is upheld by social life: As we shall see in part II, the approach is a good one when discussing the specifically human aspect of ethnic groups, but it overlooks the other facet, the general conditions by virtue of which the human species forms part of the living world and on which the humanization of social phenomena is based.

The two facets are not mutually exclusive but mutually complementary. In either case the totality of the social fact is not in doubt, but it is perceived differently. To the sociologist or social anthropologist, the social fact is totally human because it brings the human down from the apex to the base of the development curve. Conversely, the practitioner of in-depth ethnology reads the facts in terms of general biology, yet totally humanized. Many authors have outlined the stages of the humanization process, but only a few have tried to analyze it. To consider *Zinjanthropus* and observe that humanization began with the feet may be less exalting than to imagine anatomical partitions being broken down by the sheer force of a not-yet-existent brain, but it is a sound approach and one that we should adopt when studying the social edifice.

The Primitive Group[11]

The anthropoids have in common with the primates a short tooth row, including grinding molars, and an alimentary canal, including a simple stomach and intestines of medium length in which the fermentation processes of the assimilation of cellulose-containing substances play a minor role. This digestive system, upon which survival depends, emerges as the simplest and most basic element of the human economy.

The organization of the human body dictates the consumption of fleshy foods—fruit, tubers, shoots, insects, larvae. The human diet is drawn from both the vegetable and the animal kingdoms. Humans are alone among the primates in having developed the consumption of animal flesh. Monkeys do catch and eat reptiles and birds, but only incidentally. So far as archaeology enables us to judge, this situation dates back to a very distant past. The Australanthropian was already a hunter. Unlike the gorillas with their enormous canines, which consume fruit and vegetable shoots, the earliest anthropoids had small canines and were carnivorous. Of course they were not exclusively so; the idea that fossil man ate nothing but animal flesh arose because bone remains are all that has survived. If we draw up a list of the uncultivated seeds, fruit, stalks, shoots, and bark that were eaten by European peasants as recently as a hundred years ago and compare it with a list of the plants growing in our latitudes even during the rigors of the glacial periods, we can see how much edible vegetable matter was available to Neanderthal man.

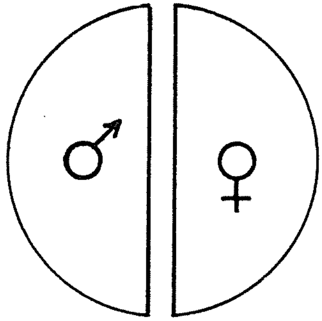
This type of food imposes the first constraint upon the form of the primitive group. Fleshy foods, whether vegetable or animal, occur only sparsely under natural conditions, and their availability is subject to considerable seasonal variations. If humans had been equipped with rasping teeth and with a ruminant's stomach, the foundations of sociology would have been radically different. Had we been able to eat herbaceous plants, we might—like the bison—have formed seasonally migrating herds composed of thousands of individuals. But being an eater of fleshy food, we were compelled from the outset to observe certain very specific conditions of group formation. The fact is an obvious one but in studying human groups it must be taken as the starting point.

The Territory

The relationship between food, territory, and population density at all stages of human technical and economic development is an equation in which the variables are correlated. In the case of the primitive group the ratios between the terms are the same whether we are dealing with Eskimos, Bushmen, Fuegians, African Pygmies, or certain Amerindians. This is so strictly true that it must be applied to the interpretation of prehistoric data. To provide themselves with food, prehistoric beings had to possess a detailed knowledge of animal and plant habitats. The old picture of the roaming primitive "horde" is certainly incorrect. Some gradual shifts of a group's territory may have occurred, as may accidental or sudden migration, but as a rule the group would have long frequented a territory whose feeding potential was known to it in minute detail. Of course it is difficult to tell what a normal Australanthropian or Archanthropian territory looked like; the established fact of the existence of huts and tents from the Palaeoanthropians onward makes the terms of the equation comparable to those for the primitive peoples of today. Indeed we arrive at very similar terms if we apply standards from the animal world to the Australanthropians and Archanthropians: However large the territories of monkeys or carnivores may be, constraints of food and shelter will limit them to some extent in terms of both area and topogaphy.

Frequentation of a territory implies making periodic journeys. The primitive group is normally nomadic—it moves from place to place as resources become available, usually exploiting its territory in a seasonal cycle. A complex relationship thus exists between the density of food resources, the area that can be covered in daily food-getting forays round the temporary abode, and the territory's total area as determined by the group's knowledge of seasonal food availabilities—a balance between food requirements, security within the habitat, and the length of boundaries with the territories of other groups. Lastly, a relationship exists between the amount of available food, the number of individuals in the group, and the size of the frequented territory. The density of food resources of course has a directly limiting effect on the number of consumers, but the territory's size is just as much a constraint. The group can only exist if daily forays are compatible with cohabitation or if periodic ones will ensure a sufficient food supply for a corresponding number of grouped individuals. The size of primitive groups today is determined by two variable factors: constant resources, on the one hand, and periodically available ones, on the other. Constant resources will provide normal subsistence for a group limited at most to some tens of individuals—usually between ten and twenty. Periodically available resources, such as a temporary abundance of salmon or reindeer, would permit several such elementary groups to band together into a larger one. Thus the texture of the social fabric is, at its very origin, closely dependent on the ratio between territory and food supply.

The Conjugal Group Technical and economic relations between husband and wife are closely complementary in all known human groups (figure 67). In the case of primitive peoples we may even speak of strict specialization. This state of affairs is the more interesting because, unlike the situation with regard to territory, it has no real parallel in the world of the higher mammals. Among the carnivores, males and females engage equally in hunting; among primates, the search for food is performed individually, and no trace of gender specialization is to be found. We might never know what the situation of the earliest anthropoids was in this respect and must therefore resort to reasoning in order to arrive at a hypothesis. The human feeding pattern involves operations of two very different orders: the acquisition by violent means of the flesh of large animals and the more peaceful acquisition of small animals, invertebrates, and plants. In all known primitive groups, hunting is normally done by men and gathering by women. This separation can be placed in a religious or social context, but its organic character is demonstrated by the fact that the dividing line between the male and female realms varies from one primitive people to another. Eskimo women do not hunt, but among some western Amerindians women are responsible for trapping rabbits. Among Bushmen gathering is not in principle supposed to be a man's job, but men do participate in finding and gathering plants



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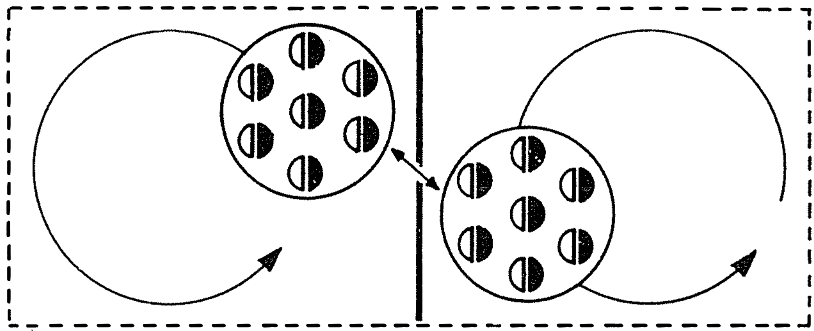

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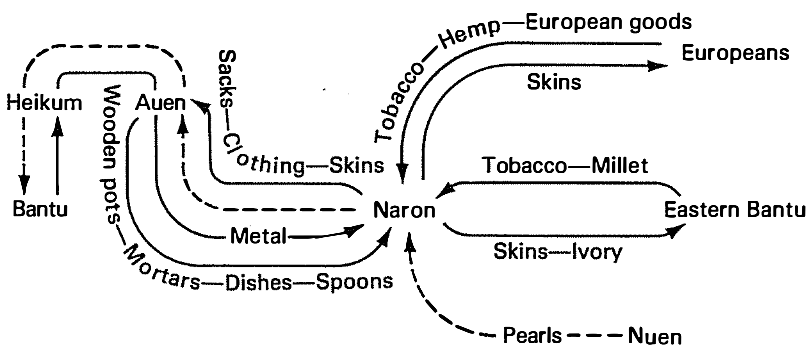

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67. The primitive couple—basic unit of the social group—complementarily sharing the ethnic group's entire stock of knowledge.

68. The nomadic group with a primitive economy travels over its territory cyclically. It maintains matrimonial and economic exchanges with complementary neighboring groups.

69. The economic relations of Naron Bushmen. Within the framework of the ethnic group, the family group operates as in figure 68. Exchanges gradually extend to other Bushmen, to Bantu, and to whites.

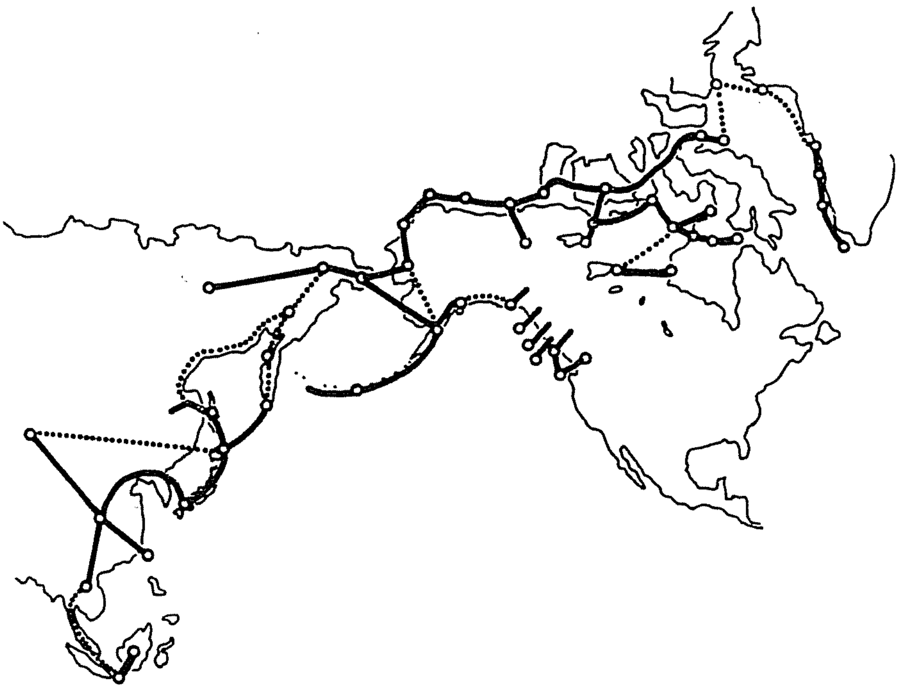
that are too scarce to brook gender specialization barriers. Thus it would seem that gender specialization is rooted in physiological characteristics. The more pronounced aggressivity of males, a frequent characteristic in the animal world, and the more restricted mobility of women explain why women specialize in searching partly for food of an animal nature and partly for vegetables. The very slow growth of human children makes women naturally less mobile, and given the dual nature of human food, the primitive group appears to have no other organic solution than to assign men to hunting and women to gathering. The humanization of this biological imperative is reflected in the social and religious forms that human groups have evolved to deal with the problem. The basic phenomenon is a general one, peculiar to humans simply by reason of the exceptional character of the human diet, but the sometimes very strict limits of specialization, and all the traditional elements evolved in order to rationalize it, form part of a social phenomenon that is exclusively human.

Technical Multivalence

The primitive group then is made up of a limited number of functionally specialized individuals of both sexes who periodically frequent a territory corresponding to their needs (figure 68). Such a group is basically an elementary subsistence unit capable of ensuring its own survival over a prolonged period, although it may sometimes band together with others. Its main characteristics are complete knowledge of survival practices and technical multivalence. With Eskimos, Australian aborigines, or Fuegians the primitive group composed of a limited number of couples and their descendants offers an overall picture of Eskimo, Australian aboriginal, or Fuegian society, possession of the whole of the group's material culture being essential to the survival of units living in isolation. More narrowly still, the totality of the group's survival culture is held by the conjugal group, in which it is shared equally by husband and wife. The couple, especially among Eskimos, may find itself temporarily isolated from all other social units. The fact that in primitive peoples technical specialization does not extend to the sphere of survival operations reflects the basic conditions of life of such groups, where each social unit must possess all the knowledge necessary for survival. Normally the elementary unit will include a sufficient number of individuals for a certain division of tasks to operate among them, older and weaker members being assigned a role in secondary operations, but such specialization does not cast doubt upon the basic principle of multivalence of each of the group's members. A permanently isolated primitive group at the *Homo* *sapiens* level is inconceivable, except perhaps in the abstract hypothesis of an isolated community breaking up into several elementary units. Normally each group forms part of a larger system comprising several other groups with which it practices exchanges of various kinds, especially matrimonial ones. Sociologists (in France, Lévi-Strauss in particular) have clearly demonstrated the role of matrimony in the organization of secondary units described in sociology by the approximate but convenient term "clans." The complex network of exchanges of goods and wives is well known, as is the role of food-acquisition and food-consumption operations in normalizing relations between groups practicing exchanges of women. At the anthropoid level, procreation and food were inseparable from one another in technoeconomic terms. The often highly complex systems of humanization of group behavior in these two essential areas merely reflect a fact that remains, at root, biological. The notion of "primitive" sexual promiscuity is as devoid of biological substance as that of the "roaming horde." The survival of animal societies presupposes a constant and precise system of organization, which varies from one species to another depending on the balance between each society and its environment. In the preceding chapters we showed that the anthropoids' neuroanatomical apparatus was as well integrated as that of animals. The development of a bioeconomic apparatus based on manual and verbal technicity presupposes equally efficient social integration—a basic cell in harmony with its food requirements and linked to neighboring cells by a network of exchanges in harmony with its reproductive requirements. Concerns relating to the acquisition of food preponderate in the primary group (the couple or family unit), and those relating to the acquisition of matrimonial partners in the wider kinship or ethnic group.

Forms of Symbiosis

The complementary technical activities of the spouses are, strictly speaking, symbiotic in that they cannot be separated at the technoeconomic level without dehumanizing the society (figures 69 and 70). Because the primitive group's survival demands that its base be as narrow as possible, the symbiosis of immediate survival is confined to the couple. But there are areas of technical and economic life where under these conditions the elementary group's survival would be endangered in the longer or shorter term, or at any rate certain products, materials, and objects regarded as necessary would not be available to the group. Manufactured objects or commodities circulate continually among the primitive peoples of today. Depending on what its specific resources may be, a small group will serve as a specialized sup-



70. The economic relations of Eskimos from the Middle Ages until the final annihilation of traditional structures. Vital commodities (ivory, skins, wood), locally manufactured goods (stone lamps, cooking pots, native copperware) and goods of Asian, Indian, or European origin (pipes, tobacco, ironware) are circulated as a result of exchanges between neighboring groups.

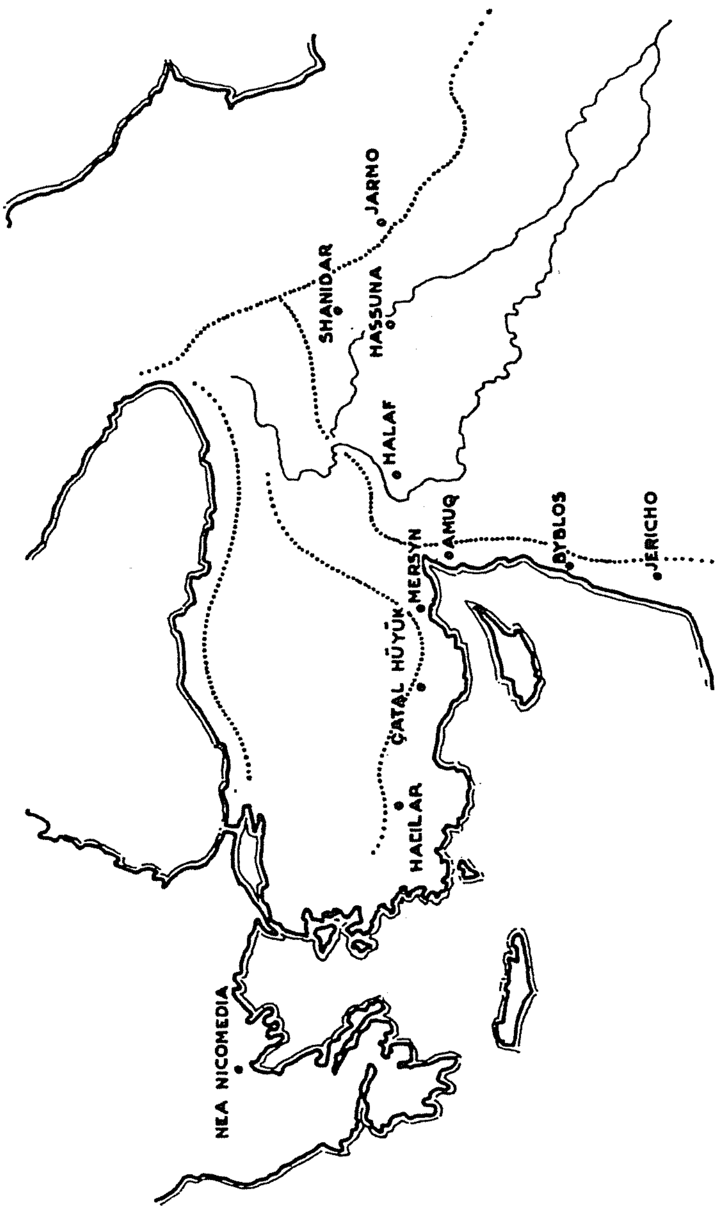
plier to its neighbors. With Eskimos the balance was until recently based on the circulation of stone lamps, wood for making harpoon handles and sleds, and reindeer skins for making winter garments. With Bushmen it was based on skins and bead ornaments made from ostrich egg shells; with Australian aborigines, decorated boomerangs and stone knives. All these objects were the subject of exchanges whose interruption would in many cases have jeopardized the survival of the elementary group supplying the object in question. Exchanges of foodstuffs, manufactured objects, and raw materials, as well as of services, form part of the essential functioning of the cluster of matrimonial cells which earlier writers used to call the "clan." They are essential at least as much to technoeconomic as to social balance, and there is no reason why this should not have been so at least as far back as the late Paleolithic. There are records to prove that flints of exceptional quality were already being circulated at that time, and the existence of regional units was beginning to become quite clearly perceptible in the different styles of objects in common use: It is unlikely therefore that territorial arrangements were very different from those known to us through more recent examples.

The idea of a primitive population pattern made up of small hordes roaming over interminable plains without any organized contact between them is contrary to the simplest biological rules. The survival of any species is predicated upon the symbiotic organization of a sufficient number of individuals—large and tightly knit groups in the case of species with massive food resources, handfuls of individuals confined within a small area in the case of species whose resources are few and far between. We have seen that humans could not have survived living in herds or living alone, and we have to acknowledge that the specifically human form of group life, with all its sociological consequences, is still maintained wherever conditions allow. In order that the phenomena of technical, economic, and social life peculiar to humankind should arise and subsist, each group's territory had to be at least relatively permanent and contiguous with other permanent territories belonging to other groups.

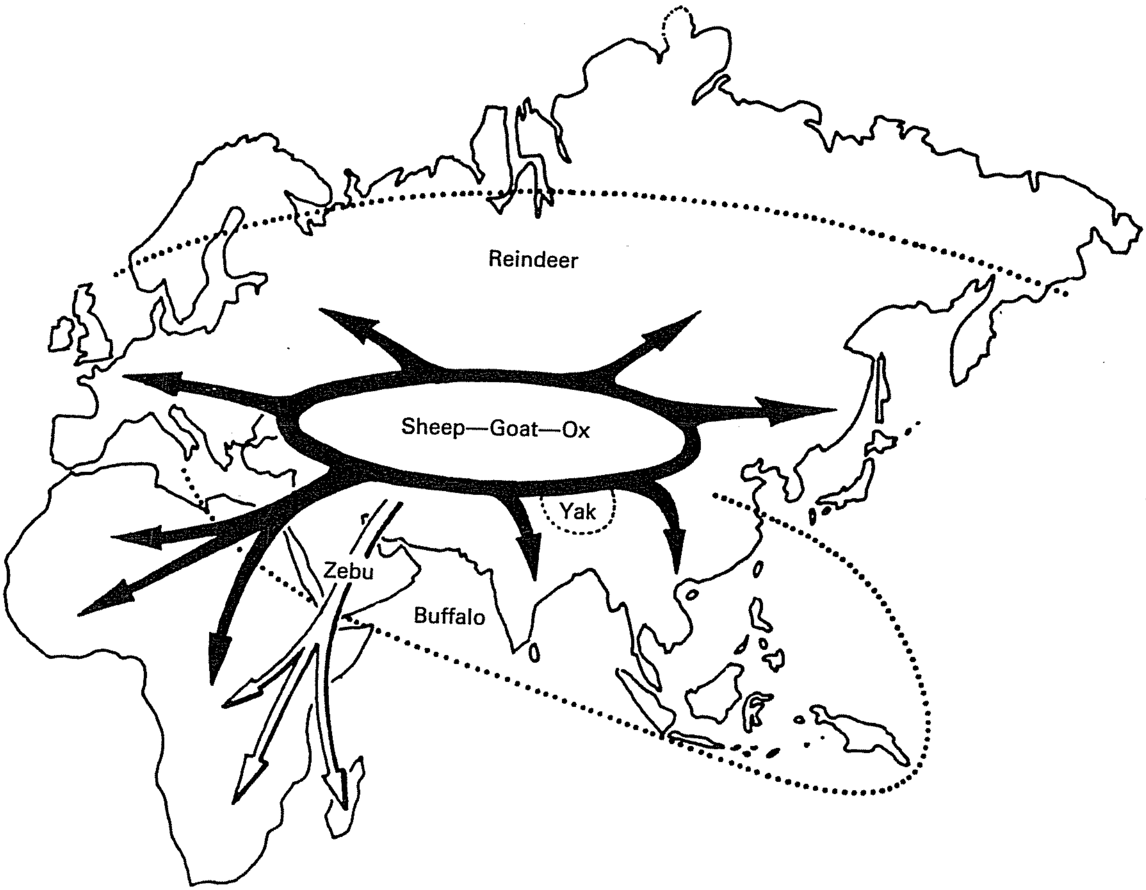
We can say with certainty that the above is true of the past forty thousand years. The fact of our ceasing to be a zoological species and becoming an "ethnic" one made it inevitable. But what of earlier times? What of the period before the emergence of *Homo sapiens* capable of thought? In chapters 3 and 4 we saw how the technical development curve turned steeply upward at that moment, and we ascribed this sudden evolution to the loss of the prefrontal bar and the consequent release of a higher form of intelligence capable of using symbols as implements for achieving control over the external environment. Such control is unthinkable without language, but it is also inconceivable without a complex social organization. If we then try to look back further than forty thousand years, what picture can we form of Pithecanthropian or Australanthropian society? The existence of continentwide technical stereotypes, coupled with lack of data about life in those societies, inevitably makes speculation abstract. The comparison with family groups of gorillas or chimpanzees—with their relative conjugal stability, their polygamous arrangements, their more or less permanent territories, and their habit of splitting up into intermediate groups—naturally comes to mind. But the social organization of these higher species, whose young mature even more slowly than ours, could not be fundamentally different from the general type to which the present-day human belongs. We can imagine their matrimonial unions to have been less long-lived, or the constraints imposed by members of the group upon each other less clear-cut, but it seems that the basic organization of anthropoid society must have been really and completely Anthropian from the outset, firmly anchored in its forms by laws that successive cultures would paraphrase into legal rules or dogmas but that owe their stability to essentially biological causes.

The Transition to an Agricultural Economy

Toward the end of the Paleolithic, a radical technoeconomic transformation took place in societies living around the Mediterranean perimeter. Between 8000 and 5000 B.C., a new technoeconomic system based on agriculture and stockbreeding made its appearance, and societies assumed a completely new form (figures 71 and 72). In terms of geological time only an instant separates the last aurochs hunter from the Mesopotamian scribe, and the emergence of the new economies is therefore a sudden explosion. That is precisely how the phenomenon was considered for a long time, and indeed some authors even today refer to the "invention" of agriculture. In a similar vein prehistorians of an earlier generation introduced the notion of at least partial domestication of the reindeer and the horse. The primitive world seems so different from that of the farmer and stockbreeder that it is difficult to see what else but an "invention" could join them together. In *Milieu et techniques* I stressed the importance of a "favorable environment" in the phenomenon of invention and the fact that the phenomenon is usually impersonal in character. There is no reason why normal rules should not have applied in the case of agriculture and stockbreeding. What we must look for are the circumstances in which the association could have occurred spontaneously. Major advances have been made in that direction during the past ten years. Near Eastern archaeology previously situated one of the earliest sources of both techniques somewhere between the Mediterranean and the Caspian. Today excavations in northern Iraq, Syria, Lebanon, Palestine, and Turkey have very considerably narrowed down the area, thus providing some factors on which an answer could be based. Finds at the now famous Jarmo, Shanidar, Zawi-Chemi, and Çatal Hüyük sites show that a transition from a primitive economy of goat hunting and gathering of uncultivated edible grain to a wheat-growing and goat-breeding one took place between 8000 and 6000 B.C., The change occurred imperceptibly. There were sickles before there was agriculture, and the moment in time at which goats ceased to be hunted as game can only be established statistically. The example of Iraq ideally demonstrates the point because there the change took place in only a few centuries without any upheavals to jeopardize cultural survival. A com-



71. Distribution of major agglomerations corresponding to proto-agricultural and primitive agricultural forms of social organization in the Eastern Mediterranean and the Near East.



72. Distribution of bovines and ovi-caprines. From the Eurasian center the species Bos, Ovis, *and* Capra *spread to all regions where it was physically possible for them to adapt, probably assimilating some local wild breeds. At the northern perimeter of the biotope their function was taken over by the domesticated reindeer, while bovine infiltration in the south was supplemented by the zebu in arid regions, the buffalo in marshland, and the yak in Tibet.*

parative investigation is necessary if we want to understand the nature of the phenomenon.

Proto-stockbreeding

The emergence of a transitional form between hunting and stockbreeding presupposes a favorable environment of a rather special kind in which the relationship between hunter and hunted is, to some extent, a personal one. This automatically excludes the large migrating herbivores, whose herds came within range of the primitive human's weapons only annually or biannually, as well as dangerous or swift-moving herbivores such as the bullock, the bison, or the horse—animals of the wide-open spaces, difficult to approach and impossible to contain. When we analyze the separate elements of a possible transitional stage, we realize that conditions relating to the physical environment must have played an even more important role than biozoological ones. It is very unlikely, for example, that stockbreeding began in the steppes of Africa or Central Asia. Further insights are obtained by studying the general situation of the most primitive animal breeders in the present-day world. Reindeer breeders in the north of Lapland and the Siberian Far East live in an environment where the reindeer still runs wild. Their method of herd management relies on a close symbiosis facilitated by the geographical environment. The mountainous terrain, both in the west and the east, is etched into by steep valleys, some tens of kilometers long, that channel and isolate the migrations of herds between the upland pastures and the winter grazing of the lowlands. The same herds go up and come down again each year, accompanied by herders who protect the animals without imposing any significant change on their natural behavior. The conditions for a changeover to stockbreeding are provided by the boundaries of the human group's territory, the normal migration paths of herbivorous herds and the regular time pattern of their migrations in search of additional food.[12] The conditions for goat breeding that once existed in northern Iraq correspond exactly to those for reindeer breeding today. Proto-stockbreeding very probably originated in mountainous terrain. The fact that the only large mammal bred by Amerindians, the Andean llama, was also a mountain-dwelling herbivore makes that probability still greater, and similar conditions are likely to have existed in the Magdalenian in the area of the Massif Central and the Pyrenean valleys. Conditions for stockbreeding were perhaps not yet ripe at that stage, but relations between groups of hunters and seasonally migrating reindeer herds probably already showed an advanced degree of familiarization.

The domestic dog, which first appears at about the same time as stock breeding, obviously played a very important role in its development. The Canidae—beaters and trackers of game—display a form of behavior very similar to the human hunter's. Although information is still lacking about the origins of the dog, which was not yet in existence in the Magdalenian, we have no difficulty in understanding how the Canidae and human came to work with one another, first in hunting and later in channeling the movements of herds.

The transition from goat and sheep breeding in a mountainous environment to breeding large herbivores on the plains has not yet been elucidated, but the indications are that if received its first impetus from the proto-stockbreeding of goats, since it developed only a short while later, spreading like an oil stain around the initial center. Breeding of sheep and oxen, pigs, donkeys, and horses—and later, in the area of the Indus, of the buffalo, the zebu, and the elephant—began to be practiced between 6000 and 3000 B.C., spreading from the Near East to Asia, Europe, and Africa (figure 72). The only aspect of this movement about which there is any doubt is its original impetus; except for the American llama, all animal husbandry forms a consistent historical whole. Once the principle became established, its application to new species presented fewer difficulties than the transition from pottery to metallurgy. It is interesting to note that with the exception of the reindeer, whose food requirements are altogether special, all herbivores used for breeding (bovines, sheep, horses, camels) are grass-eating animals that live in large groups on continuous expanses of open grassland and band together when fleeing from danger. With animals of this kind, the game-beating methods of the herders and their dogs are highly effective. Leaf-eating animals (Cervidae), which live in small herds under cover of trees and scatter when fleeing, have proved resistant to stock-breeding.

Proto-agriculture

An important point to be noted is that agriculture sprang up at the same period and in the same parts of the world as stockbreeding (figure 71). This is hardly surprising if we recall what was said earlier about the technical and economic composition of the primitive group. Human groups were formed on the basis of a mixed-diet economy and their balance throughout prehistory depended on the complementary exploitation of the animal and plant kingdoms. A separation between farmers and herders must have taken place at an early stage, perhaps from the very outset. We can imagine primitive social cells of proto-stockbreeders relying on gathering for the vegetable part of their diet as we can imagine proto-farmers supplementing their vegetable diet with hunting. Neighboring communities probably evolved more or less synchronously toward organized production of plants and animals. If we acknowledge that the exceptional topography of the Near East was conducive to the channeling of herds and the transition to proto-stockbreeding, we must also allow that the botanical conditions in the same regions favored a transition to agriculture. The ethnic units concerned were not, however, necessarily the same.

Among the innumerable wild plants that can be used as foodstuffs, those with edible grains play a role of the first importance throughout the temperate zone and especially in its southern part, which includes Africa north of the tropics, the Middle East, Central Asia, and America. Before the present era of dryness, at the time when the transition to proto-agriculture was taking place, the periodic exploitation of herbaceous grain-bearing plants undoubtedly formed an essential part of the search for food. Among such plants Gramineae proper occupy an important place. Although their grains are small, they have high nutritive value and can be stored for prolonged periods. It was recently established that large-grained Gramineae, the ancestors of today's cereal crops, were growing in the Near East and in particular in northern Iraq at least from the middle of the last Ice Age. Thus the basic conditions for the increasingly agricultural exploitation of wild wheat existed in the very regions that offer the first evidence of goat breeding.

Exactly how the transition from one economy to the other occurred is still a matter for conjecture. Still we can readily imagine that communities of hunters and plant gatherers with access to game animals whose seasonal movements were channeled in river valleys, as well as to a wild food plant growing extensively over a very large habitat, might find themselves engaging in a more and more intimate form of exploitation of this plant without any disturbance to the previous balance of their lives. Between the seventeenth and the early twentieth centuries, Wisconsin Indians in that part of their region where Chicago stands today had an economy that suggests the successive stages that such a development may have taken. A gramineous plant (*Zizania aquatica,* or wild rice) growing in the marshes around Lake Superior and Lake Michigan used to be exploited to a considerable extent by several tribes. The manner of this exploitation is particularly instructive. The Dakota Sioux, hunters of bison and gatherers of wild plants, would simply harvest the rice when it ripened, using it to supplement their diet. The Menomini or Algonquin Indians, forest hunters and gatherers of maple sugar, lived in close symbiosis with the wild rice that constituted their staple diet in autumn and winter. They neither prepared the soil nor sowed seeds but only tied the ears of rice in bundles to protect the grain from birds.

Areas in which wild rice grew were distributed in accordance with a highly elaborate system of land property rights. Similar instances of protection and personal attribution of wild plant habitats are known in other primitive groups.

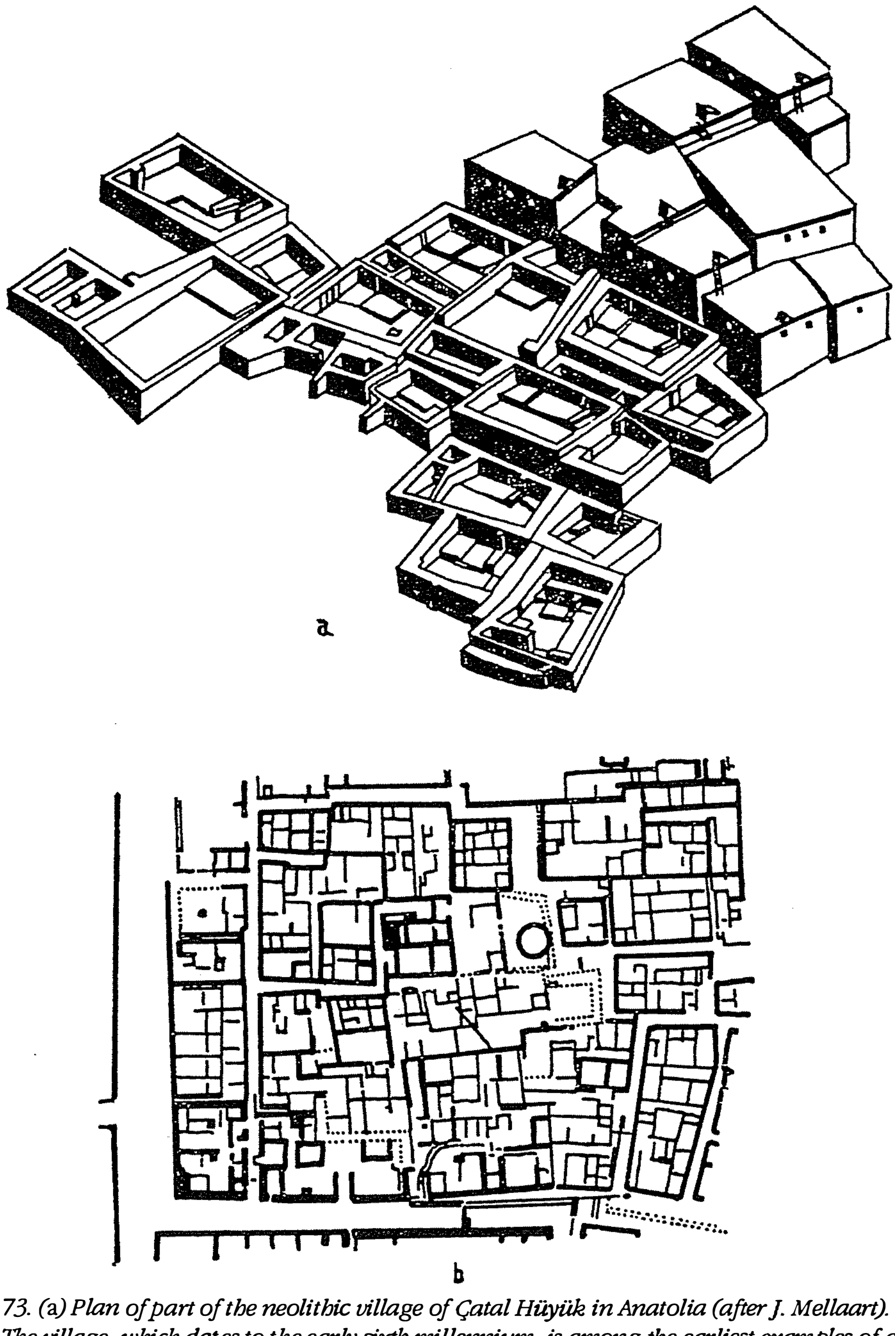
The way in which a "neolithic"-type economy at least partially based on sedentary plant resources and on partly nomadic animal resources came to emerge is fairly clear. In this case agriculture and animal husbandry are as one, and the dividing line between the primitive economy and an economy of farmer-stockbreeders is imperceptible; the two forms really mesh with one another. A little further on we shall see that in Near Eastern societies this situation gave way fairly rapidly to an exclusively agricultural-pastoral economy, but around the edges of the original agricultural world the initial situation (proto-farmers or proto-stockbreeders balancing their economy by hunting or gathering) persisted, allowing the necessary transitions to take place gradually. The first agricultural populations of Europe, more recent than those of the Mediterranean, came into contact with agriculture and animal husbandry between 6000 and 4000 B.C., Cereals and cattle came in at the same time, but neither played anything like an essential role at the beginning. In proportions that vary from one region to another, the new economy existed side by side with traditional hunting and gathering techniques. Surprisingly, bones of game animals found in certain Neolithic sites in France are as numerous as cattle bones, and the little information we have about plants at that time shows that in the Iron Age wild cereals still accounted for an appreciable part of the human diet. Existing ideas about the agricultural "revolution"—which was an instantaneous event on the geological time scale but must have been, if not imperceptible, then at least very gradual to the generations that experienced it—will certainly have to be reviewed in the future.

Agriculture and Stockbreeding

Whether the agrarian economy came in gradually, and whatever forms the transition may have taken in peripheral regions, the process that began in the Near East during the Mesolithic era toward 8000 B.C., had, by 5000 B.C., completely transformed the structure of societies from Mesopotamia to Turkey, Greece, and Egypt (figure 72). Even before the appearance of pottery between 6000 and 5000 B.C., the foundations for the new economy had been laid by the association of wheat and barley with sheep, goats, and pigs, and the first permanent villages had come into existence. Cultural variations were already considerable. Not enough records are available to provide us with a detailed picture of the way of life of these first farmer-stockbreeders, whose environment was not then the desert it has since become, but we do know that they were sedentary—at any rate for a large part of the year—since there is evidence of real villages and organizational forms whereby periodic contact at least was maintained between the cattle and the fixed habitat.

From a certain stage of settled agriculture onward, the proto-stockbreeding system that obliged the herders to follow their seasonally migrating herd was probably at the origin of the separation of Near Eastern populations into sedentary and nomadic elements. Proto-stockbreeding was a form of economic balance that did not require a break with earlier structures. Settled agriculture, however, was a new form, and its consequences were extremely far-reaching. We can imagine proto-farmers as being attached for part of the year to areas in which wild rice was plentiful, but the concept of sedentarization becomes meaningful only when the group's survival depends entirely on cultivated grain. Permanent settlement was dictated simultaneously by having to tend the fields and by the presence of food stocks.[13]

Complete plans of agricultural villages during the first period are practically nonexistent, but recent excavations in Mesopotamia, Turkey, Syria, Lebanon, and Israel have brought to light some important facts concerning preceramic and early ceramic settlements (figure 73). There are also many records of the first stage of agricultural penetration in both Western and Eastern Europe. Their functional configuration is more or less uniform: They consisted of clusters of dwellings of various forms and materials, grouped close together and not including any buildings that would suggest marked social differences. The preurban settlements of Palestine, Lebanon, and Turkey possibly included shrines or richer-than-average houses but not yet any real palaces, and the distance between the top and bottom of the social ladder was not yet as great as it would become a little later on. This nucleus of homes was encircled by protective structures—palisades or ramparts—and equipped with cattle yards and sunken store pits. An immediately noticeable fact, by comparison with primitive groups, is the concentration of a relatively large number of individuals in one place. The consequences of settled agriculture are uniform in all areas to which it extends: They are the forming of a human group of several tens of individuals concentrated round stocks of food and protected by defense works against the natural environment and fellow human beings. These immediate consequences were the cause of the complete transformation of the way of life of human societies. The most striking features of this transformation—capitalization, social domination, military hegemony—have been well inventoried by sociologists, so all



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73. (a) Plan of part of the neolithic village of Çatal Hüyük in Anatolia (after J. Mellaart). The village, which dates to the early sixth millennium, is among the earliest examples of a permanent settlement with an agricultural-pastoral economy. (b) Plan of part of the second millennium city of Mohenjo-Daro in India.

we need do in the present context is to mention those points upon which the technoeconomic function appears to have a direct bearing.

Settled and Nomadic Groups

In the societies in which it originated, settled agriculture gave rise to a separation between farmers who also bred a small number of animals and nomads who were large-scale stockbreeders. The separation persists to this day and imparts a specific character to a number of civilizations from South Africa to China. The group specialization typical of our savannas and steppes probably resembles that which existed in primitive communities; in both cases a symbiosis takes place. Like the primitive man/woman couple, the community is divided into two complementary technical groups, and the same causes account for the greater or lesser mobility of each of the two groups living in symbiosis and dealing, respectively, with animals and plants. This new division of the technical and economic apparatus is functionally of the same nature as earlier ones, but its elements are radically different. The symbiosis between an agricultural and a pastoral society is no longer one in which each of the two elements belongs to the same culture and is at an equivalent technical level. The two form distinct technoeconomic systems, economically linked but socially separate, no longer mutually complementary as in matrimony but often closed to one another. A more complex structure, in which two distinct societies maintain a similar relationship, has been superimposed on the complementarity of the couple and of allied groups within a system of exchanges. The situation is comparable to the development of vegetative systems from the association of unattached cells at the bottom end of the biological scale to complex organisms requiring the coordination of a considerable number of aggregated cells at the top end. Fr. Teilhard de Chardin expressed the same thought when commenting on the replacement of the zoological element by the social. Similar causes naturally produce similar effects: Pastoral-agricultural societies owe their special characteristics to increased population density, which is determined by and required for food production, itself both the cause and the effect of the altered complementarity relationship. That is the starting point of the complex history of the symbiosis between farmers and herders. Now one, now the other, of these two economically inseparable groups has dominated in different societies and different historical situations. For thousands of years, from biblical antiquity until the invasions of the Huns and Mongols or, in Africa, the migrations of the Peuls and Bantu, much of the Old World's history reflects this alternation.

War Another feature reproduced in the economic apparatus of today is the tendency of this complementarity between farmers and herders to assume violent forms. Here again, we are not dealing with a radically new situation but rather with a basic characteristic manifesting itself on a different scale and in a changed form. In primitive societies murder is an affair between individuals within the system of alliances, and the motives behind vendettas waged by fractions of a group are generally of an individual kind. Rivalry in the acquisition of land, goods, or women arise between elements belonging to different alliance systems or ethnic groups. While there is no reason whatever to suppose that the primitive human was any less aggressive than humans are today, it is important to note that, for organic reasons, aggression in primitive peoples takes very different forms from those of war as rendered possible by the existence of large sedentary units. Such war forms part of innovative technical activity and, as such, is to this day connected with social progress. The aggressive behavior of human communities did not become sharply differentiated from their acquisitive behavior until a very recent stage in history—if indeed the attitudes existing today offer evidence of change. The techniques of aggression have always been closely associated with acquisition. For the primitive human the first purpose of such techniques was hunting, where aggression and the acquisition of food merge into one. During the transition to agricultural societies, this fundamental connection was disturbed by the deviation of the social apparatus from the biological course of human evolution. Aggressive behavior has been a fact of human life at least since the Australanthropians, and the accelerated development of the social apparatus has not had any effect on the slow maturing of the phylum. Hunting and war have gradually become assimilated with one another, the exercise of both activities becoming concentrated in a new class thrown up by the new economy, the class of men-at-arms. Cereals and cattle, the keys to the enfranchisement of primitive humankind, opened the way to progress but could not throw off human genetic servitudes. Our history has taken place on three conflicting levels: that of natural history, in which *Homo sapiens* of the twentieth century is hardly different from *Homo sapiens* of three hundred centuries ago; that of social evolution, in which the biological group's basic structures have adapted, with varying degrees of success, to the structures resulting from technical evolution; and at the level of technical evolution, that astonishing excrescence from which our species derives its efficacy but which it is not biologically equipped to control. Between these two extremes—the physical human at one end, and, at the other, the techniques of which the human sometimes seems to be no more than a tool—some mediation is achieved by a social edifice whose responses to new problems are always a little delayed and by moral concepts upheld by religions or ideologies and deeply rooted in social morality. By giving us a counterimage of the biological human, these moral concepts help to create an image—still very abstract—of a *Homo sapiens* beyond the *sapiens* stage. The outer shell of the farmer is still the same as the mammoth-slayer's, but the economic system that made the farmer a producer of resources also made the farmer, by turns, hunter and prey.

Social Classes

Storage is a fundamental aspect of animal and plant production at the agricultural-pastoral level. The group is immobilized round its hoard of cereals, dates, or olives just as nomadic herders are tied to the movements of their herds. The new relationship between humans and their food resources inevitably brings about an adjustment of social relations and thus determines a stratified social organization, the very mainspring of progress. The first villages were followed in less than two thousand years by the first towns with all they imply by way of chiefs, warriors, servants, and tied villagers. The theory of this evolution was expounded by historical materialism a century ago. We need only remark in passing that it represented a normal process of achieving social balance and not, as the theories of early sociologists would have it, a pathological aberration. While it is true to say that social forms lagged seriously behind the process of economic adaptation, they still provided the best possible response to the insoluble dilemma of phyletic as against technical evolution. Throughout the enormous wastage of humans and resources that denotes history, it is always the human who serves as the connecting link between successive stages.

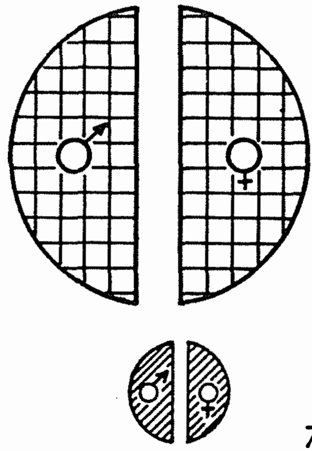
The Freeing of the Technician

Prehistorians drew attention long ago to the suddenness with which major "inventions" made their appearance in the history of human societies. Toward 6000 B.C., when agriculture had only just consolidated its hold, pottery seems already to have reached an advanced stage, and metallurgy and writing followed suit toward 3500 B.C. After only 2,500 years of agriculture, oriental societies were ready to acquire the technical and economic foundations upon which the human edifice still rests today. Yet it had taken *Homo sapiens* thirty thousand years to reach the threshold of agriculture. This suggests that the constituents of the human group now included an element that had been lacking in primitive societies: The group had become capable of covering the food requirements of individuals engaged in tasks not directly related to food production (figures 74 and 75).

The cycle of technical progress starts with storable food. Of course animal breeders played an essential role in the evolutionary process, but it is with the sedentary part of the population that it must have begun. The "inventions" of pottery and metals had two causes: the new tempo of work and the presence of stored food resources. The exercise of crafts presupposes the freeing of a very considerable amount of time: This may take the form of food-producing individuals being freed during intervals in farm work, or of specialists totally exempted from food production tasks. The fluctuating seasonal character of agricultural work and the availability of more or less constant food reserves create the conditions for a "favorable environment." Just as the Australanthropians' freed hand did not stay empty for long, so too the free time of agricultural societies soon became filled with activity.

Settled existence was favorable to the development of techniques such as basketry and weaving, which had undoubtedly existed earlier but which the requirements of farming and the reduced availability of animal hides now promoted to the status of necessities. But the most important innovation had to do with the handling of fire, and it was around the "furnace crafts" that technical progress crystallized. The origin of such arts lies in the very distant past. The Paleolithic human already had some accidental acquaintance with baking clays, and we know that Châtelperronians and Aurignacians as far back as 35,000 B.C. found and gathered native metals such as iron pyrites and galena crystals, probably using them for purposes relating to religion or magic. But the acquaintance did not lead to pottery or metallurgy because the primitive group lacked the countless hours that must be spent by countless individuals before an invention can materialize.

Availability of time of course was not the only factor. Steady population growth and the community's increasing needs created a strong demand for innovation, such as is not felt to the same degree by societies that have already achieved a balance. Stabilization in space and the possibility of producing additional resources simply by increasing the number of individuals in the group created a special inner environment that coincided with the freeing of many hours of time. This was the basis upon which the snowball of accelerated technical progress began to roll, within a social system composed of dense territorial units communicating with each other through a network of peaceful or warlike exchanges.



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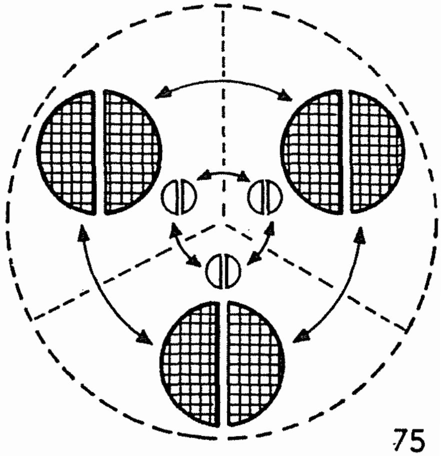

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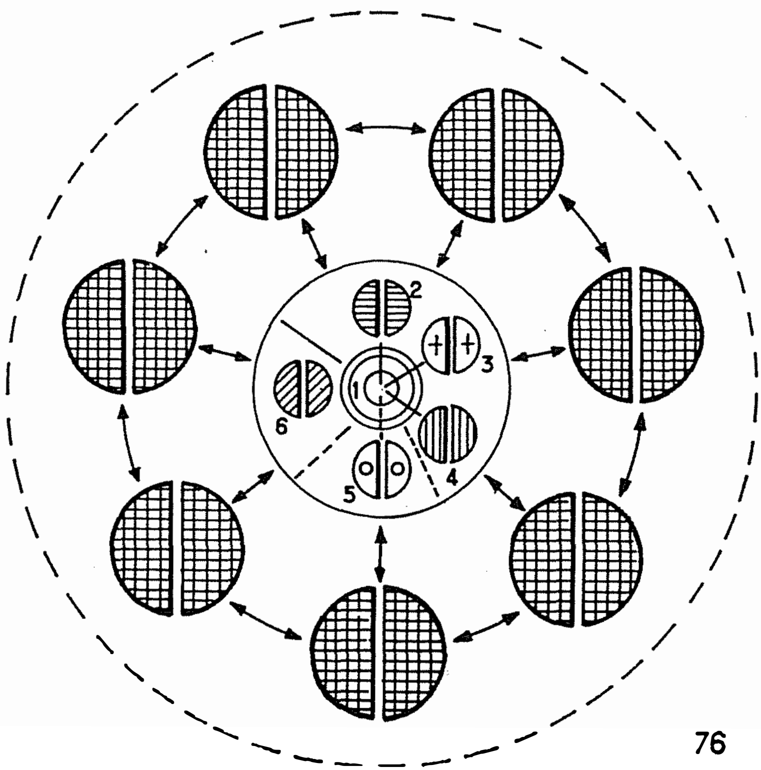

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74. Functional diagram of the elementary agricultural group. Necessities are shared between individuals grouped by gender in a number of social subsystems based on the extended family. The system allows a certain margin for specialization based, in particular, on the age group. From the Bronze Age onward, the agricultural group is in many

Civilization

The transition from the essentially rural Neolithic stage to the age of metals coincided with the development of a way of life that in fact was its direct consequence—"civilization" in the strict sense of the term, with the city beginning to play a part in the functioning of the ethnic organism (figure 76). No doubt the transition occurred very gradually. While we may expect to discover evidence of ever older semiurbanized units going back to the very beginnings of proto-agriculture, the first city will probably never be found. All we need to know in order to understand the urban phenomenon can be inferred from archaeological records relating to the period between 6000 and 3000 B.C. already available from Mesopotamia to Egypt.

The transition from villages built on natural raised ground to the first towns built on mounds on top of the ruins of earlier villages is literally imperceptible. Archaeological investigations reveal that successive layers of such ruins were permanently occupied from Neolithic times. Civilization is reflected in a functional pattern, not in morphological features that are clear-cut from the start. The pattern is that of a group of villages organically linked to an agglomeration that fulfills the role of a capital. Such a pattern presupposes an established social hierarchy and the concentration of authority and of the group's "capital" of grain in the hands of an elite based on military and religious power. From the technoeconomic point of view, the most important fact here is the artisan's entry upon the scene, for it is on the artisan that all technical evolution depends.

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cases supplemented by a smaller one—individual or collective—of artisans (blacksmith or female potter, carpenter, weaver, etc.).

75. Spatial organization of agricultural groups. Each group has its own territory, at least relatively, and maintains exchanges with neighboring groups. The exchanges may be so far-reaching as to include matrimony, or they may stop at exchanges of goods. The artisans maintain among them a system of relations of the same type, which may extend over very large areas and may be accompanied by strict endogamy.

76. Functional diagram of the city. The city serves as the center for the territory and is surrounded by a group of agricultural villages of the type shown in figure 75, from which it derives its resources and which it holds together. The central authority (1) is linked with military (2), religious (3), and legal (4) functions, which tend to become specialized in distinct individuals or classes. The degree of segregation of the merchants (5) from the ruling classes is variable, but the indirect influence and the alliances of this group always endow it with considerable importance. The artisans (6) and small traders, although dependent upon the ruling classes, are completely isolated from them. Some members of these groups achieve advancement, however, thanks to the permeability of the merchant class.

Civilization thus depends on the artisan, but ethnology has not yet fully defined his or her position within the functional apparatus. In all historical periods and in all nations, even when their activities are closely integrated in the religious system, artisans were relegated to the back of the stage. The priest is "holy," the warrior "heroic," the hunter "brave"; society acknowledges the orator's "prestige" and will even concede "nobility" to the peasant's tasks, but what the artisan does is merely "skillful." Artisans embody what is most Anthropian in humans, but as we survey their long history we begin to suspect that they represent only one of the two poles—the hand, the antithesis of meditative thought. Society's discrimination in favor of the "intellectual" as against the "technician," which still persists today, reflects an anthropoid scale of values on which technical activity comes lower down than language, and working with the most tangible elements of reality lower down than working with symbols. In agricultural societies, wealth—the possession of money—began at a very early stage to be reckoned on a scale parallel to the functions of the priest, the chieftain, the manufacturer, or the farmer. Even today, when the divinization of inventions has led to a veritable cult of technology, the soldier-astronaut who travels in a rocket is perceived as a hero but the engineer who designs one merely as a servant of science—a *hand*. Once we have glimpsed the deep biological roots of such well-known social situations, we can no longer ascribe the ascent of the human to the workings of chance or of mysterious predestination, for we can see that "chance" has been working in the same direction from the very start, and that the mystery is in the gradually evolving whole, not in its parts.

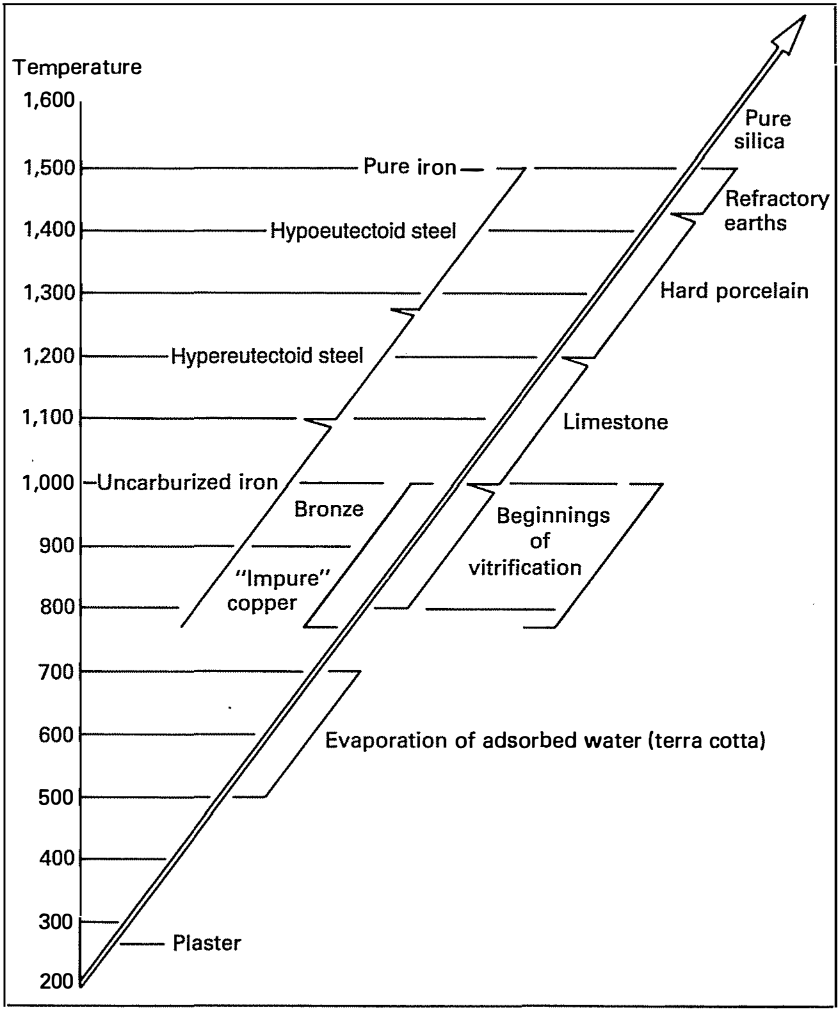
The initial apparatus of civilization was also constituted as a single whole. Settled existence, itself the product of the storage of agricultural goods, led to the forming of hierarchical societies and to the concentration of wealth and of dual military and religious power in capital cities. The chiefs and their capital city were organically the "head" of the ethnic body—an etymological image that reflects the fact that an organization of functions represented by hierarchically organized social groups now took the place of the hierarchical division of functions between individuals within the primitive group. The development of the social apparatus into a macroorganism springs from the same source as the development of all other living societies from corals to bees. The individual human organism too is designed on the same model; it too is an aggregation of specialized cells grouped into organs responsible for each of the various sectors of the organism's economy. It is not surprising therefore that when civilized individuals adopt a complex form of grouping, they come more and more to resemble a body whose parts are increasingly subordinated to the whole.

A characteristic feature of the social body everywhere is that although its form has to do with evolution, the rate of its development does not. Not a great deal of evolution goes on near the top of the pyramid. Appreciable progress has no doubt been achieved in religious and philosophical thinking since the founding of the first Mesopotamian cities, but can we claim that anyone today thinks (in the strict sense) better than Plato? It seems that *Homo sapiens* achieved his full psychological potential for exploring the immaterial at a very early stage. All we can do now is wait for the evolutionary drift to carry us slowly toward a clearer view. If intellectual progress is taking place at all, it is still imperceptible in biological terms and is more a matter of expanded means and fields of speculation than of improved psychophysiological equipment.

On the other hand, the disproportion between the rate of technical progress and that of biological evolution is an obvious point that does not need to be labored. Once the agricultural organism was established, humankind entered upon a process of evolution vertically upward to the present day. On the basis of what is still a very simple functional pattern (chief, capital city, capital, manufacturers, rural producers), social institutions maintain an uneasy peace between a *de principe* harmonious social order and a *de facto* situation largely at the mercy of technical and economic imperatives. Our techniques, which have been an extension of our bodies since the first Australanthropian made the first chopper, have reenacted at dizzying speed the events of millions of years of geological evolution until, today, we can already make an artificial nervous system and an electronic intelligence. The founding of the first cities and the birth of civilization thus mark, in imperative form, the beginning of the dialogue between the physical human—borne on the same tide as the dinosaur—and technology, the child of human intelligence but completely freed from all genetic ties.

The Rise of Prometheus

Metallurgy is the only one of the furnace crafts (figure 77) directly involved in the development of civilized societies, yet it must be seen as part of the inseparable whole it forms with all such crafts, including the making of pottery, glass, dyes, plaster, and whitewash. Invention should never be imagined as a unique act of genius whereby an isolated new technique is produced out of thin air. Individual genius needs substantial soil to grow in. Before metallurgy could come into being, a whole body of techniques had to be practiced for many centuries by a large number of indi-



77. The furnace arts. The connections among metal, ceramic, and glassmaking techniques are apparent from the scale of temperatures.

viduals. It is impossible to put a date on the domestication of fire, but we do know that Sinanthropians knew how to keep a fire burning and that Palaeoanthropians had fires. The first technical application for a purpose other than cooking goes back to the Upper Paleolithic, around 35,000 B.C. From that time on there is evidence of iron ocher being roasted to produce a range of dyes varying in color from a yellowish orange to a purplish red. Dye making was by far the earliest of the furnace crafts. No record exists to suggest that clay was baked for a practical purpose, although there are traces of this occurring accidentally in cave dwellers' hearths. Not until about 6000 B.C. does baking of modeled figurines and of clay ovens seem to have occurred (still accidentally but more frequently) in Iraq, and only toward 5000 B.C. did pottery proper emerge and spread across the early agricultural societies. Plaster made its first appearance at about the same time, and floors and walls of dwellings from Mesopotamia to the Mediterranian began to be covered with gypsum reduced to plaster by firing.

Pottery and plaster making imply some experience in controlling temperatures between 500 and 700 degrees centigrade and a possibility of exceeding 1,000 degrees in a few well-aerated parts of the hearth. We may therefore consider that toward 4000 B.C., countless potters and limeburners were handling fires whose qualities were gradually approaching those required for reducing metal oxides to metals. The use of lime derived from calcareous rock further suggests that a reducing chemical capable of lowering the melting point of the ore may have been present in the hearth. An environment potentially favorable to the emergence of metallurgy was thus present.

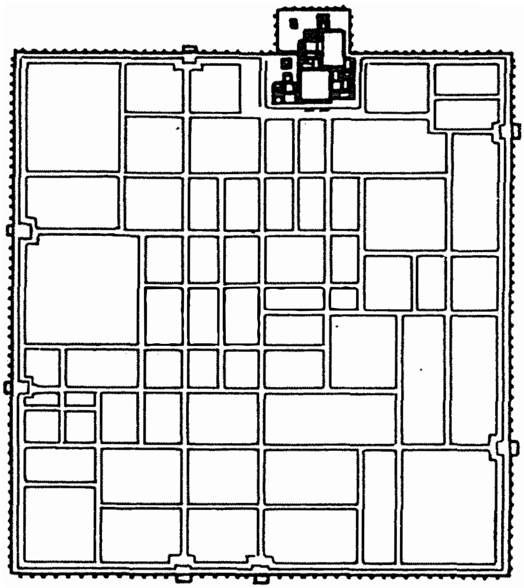
Temperature and a reducing chemical are two of the three terms of the metallurgical equation. The third—the ore itself—was likewise available, for in addition to ocherous iron (which is not readily reducible), malachite with its high copper content now appears among the dyes. Used probably as a cosmetic, it was common in Egypt. While we do not yet know anything precise about the discovery of copper reduction, we do know that between 5000 and 3000 B.C. copper had become common from Egypt to Mesopotamia, and that by 2000 B.C., when iron came on the scene, the use of bronze or copper had spread like an oil stain from the Atlantic to China.

The fact that the beginnings of metallurgy coincided with the first cities is more than pure chance. It reflects the application of a technoeconomic formula already fraught with all the consequences it was to have for the history of the great civilizations. It is not possible to understand the phenomenon of civilization through any one of its separate elements. To try to grasp it by studying the development of a religious or political idea is to stand the problem on its head, but to interpret civilization solely in terms of technical and economic forces is equally mistaken. A cycle of interactions is at work between the base and the superstructure. Ideology is undoubtedly molded by technoeconomic factors, yet it also influences their development; as we saw in the preceding chapters, a similar interaction exists between the nervous system and the body. In the context of the present chapter, the primacy of basic technical and economic factors seems evident. It may subsequently be possible to trace the course of the ideological currents by which the individual has, over the ages, sought to escape from the power of the material forces inexorably transforming him or her into a depersonalized cell. But unless we first provide ourselves with a clear picture of the skeleton and muscles of society, we will never penetrate beyond the outer layer of its skin. The peoples on whom we base our memory of the earliest days of modern society were aware of the ambiguous nature of the organism then just coming into being. It is not by chance that the myth of Prometheus gives us both Man triumphant over the gods and Man shackled by the gods, or that Genesis speaks of the murder of Abel by the farmer Cain, builder of the first city and ancestor of Tubalcain, the first metallurgist.

Technicians then are the masters of civilization because they have mastered the furnace crafts. From the hearth (which they learned to operate in several centuries of pottery making) comes plaster, soon to be followed by copper and bronze. Slag and clinker, the residues of metallurgical processing, are at the origin of glassmaking. But the artisan is an enslaved demiurge. We have already seen that the artisan's position within the technoeconomic machine is a subordinate one. It is he, Vulcan the all-powerful, the lame, the derided, who forges weapons for the chieftains' use, makes jewels for their wives, hammers out dishes for the gods. His is the "hand" that over the course of fifty centuries, during which humanity's ideological levels remain practically unchanged, provides the "head" with the means of ensuring the triumph of the artificial over the natural world. The mood of malediction that hangs over the furnace artisan's history in most civilizations is the reflection of a frustration intuitively felt by humans from the earliest times.

The City

Toward 2000 B.C. cities from Egypt to Turkey, to the Indus, to China, and to the northern shores of the Mediterranean bear witness to the first great surge of civilization (figures 76, 78, and 79). Their structure is singularly uniform, but this need



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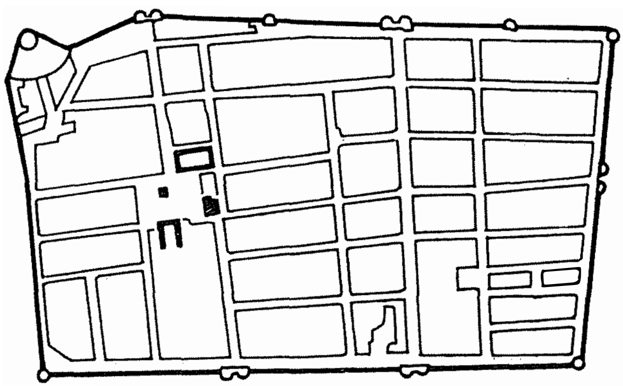

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78. Plan of the Assyrian city of Khorsabad (eighth century B.C.).

79. Plan of Aigues-Mortes, France.

not surprise us if we regard the city as the embodiment of the new functional system adopted by the human community.

At all periods of history, in America as well as in non–Mediterranean Europe or Black Africa, the same functional apparatus has come into being whenever a group with an already established agriculture crossed the threshold into the world of metallurgy. The city, enclosed within its defensive structures, built round its stocks of grain and its treasure-house, is the hub of the mechanism, and the king or his representative, the military dignitaries, and the priests, served by a populace of domestics and slaves, are its dynamic cells. Artisans form a series of generally endogamous cells inside the urban mechanism. Their fortunes are linked with the ruling classes, but their status is generally neither quite that of the slave nor that of one who has attained full human dignity. The city and its organs are connected to the countryside, which supplies them with food and which they control through a network of stewards acting as intermediaries between the king and the generally enslaved peasantry (figure 76). Fairly early a further social element, the merchant—locally based or, more often, itinerant—enters upon the scene at the same time as money, making the basic mechanism more complex but not altering its structure.

Thus we see that ever since the first agrarian economies came into existence, the trend has been in the direction of supersettlement, the result of a capitalism directly consequent upon the group's immobilization around a stock of grain. This immobilization entailed the establishment of a defensive apparatus, which in turn led inevitably to the hierarchical organization of society. The development was perfectly normal in that the social machine, like a living organism, had a head inside which the group's ideology was created, arms that forged its means of action, and an extensive system of acquisition and consumption to meet the group's requirements for maintenance and growth.

The development of the urbanized organism (a *civilized* organism in the etymological sense) leads inevitably to all the negative features of present-day society. Indeed the artificial organism cannot function effectively without accentuated social segregation, its particular form of the cellular specialization common to all animate beings: the landlord, the peasant, the prisoner, are social categories whose effectiveness is directly proportional to the distance society sets between their functions. In agricultural societies, social injustice and human triumph over nature are two sides of the same coin.

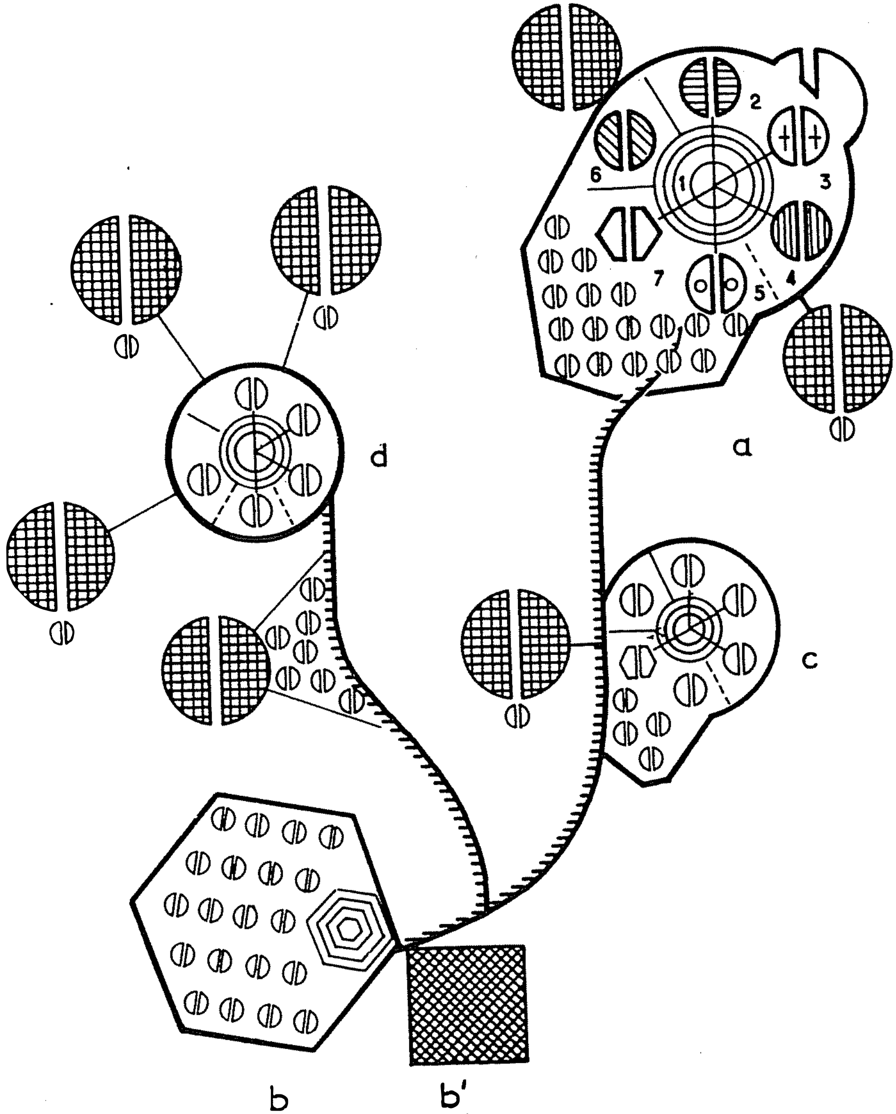
The polarization of specialists within the city's defensive walls is another feature peculiar to civilization. The artisan, as we saw, is a consumer of food surpluses, a luxury not accessible to primitive societies, an advance on capital that the group is willing to pay in expectation of future benefits. The artisan's existence is possible only thanks to an overprovided dominant ruling class. This is still just as true in the world of today: Technical research is still a luxury indulged in by civilizations which, their different political systems notwithstanding, have a large surplus of capital at their disposal, and its purpose is still to perpetuate the technical overprovisioning of the community's ruling stratum. The artisan was always a maker of weapons first, a maker of jewelry second, and only then a maker of tools. It is because they partook of the ruling group's technical overprovisioning that the carpenter and the stonemason, builders of palaces both, came so early into the possession of metal tools. Not until the Iron Age, when the almost ubiquitous availability of ore made it possible for a small-scale rural metallurgical industry to develop, did the peasant exchange the wooden hoe for a metal one.

We can now see more clearly what are the consistent elements in the social forms of humanity as it was until a very short time ago and still is in some parts of the world. From the outset the agricultural technoeconomic apparatus contained within it all the factors of both technical progress and social strife. The picture we have drawn would be incomplete, however, if we failed to point out that the furnace crafts were not alone responsible for the rise of the first cities. Writing was born at the same time as ironworking. This again was not a matter of chance but a logical development. The first *sapiens* societies of the Upper Paleolithic differed from Palaeoanthropian societies not only by their extraordinary technical advances but also by the fact that they produced the world's earliest graphic notations. As soon as agricultural societies began to emerge from the transitional period and to assume their definitive structure, they also began to develop a symbolic instrument of expression in order to meet their new needs. This instrument, as we know from numerous records, first came into being as a reckoning tool and developed very rapidly into an instrument of historical memory. To put it differently, the means of keeping written accounts emerged at the precise moment when agrarian capitalism began to become established: The first genealogies were written at the precise moment when social hierarchization began to affirm itself. This graphic aspect of the development of human memory will be dealt with in the next chapter.

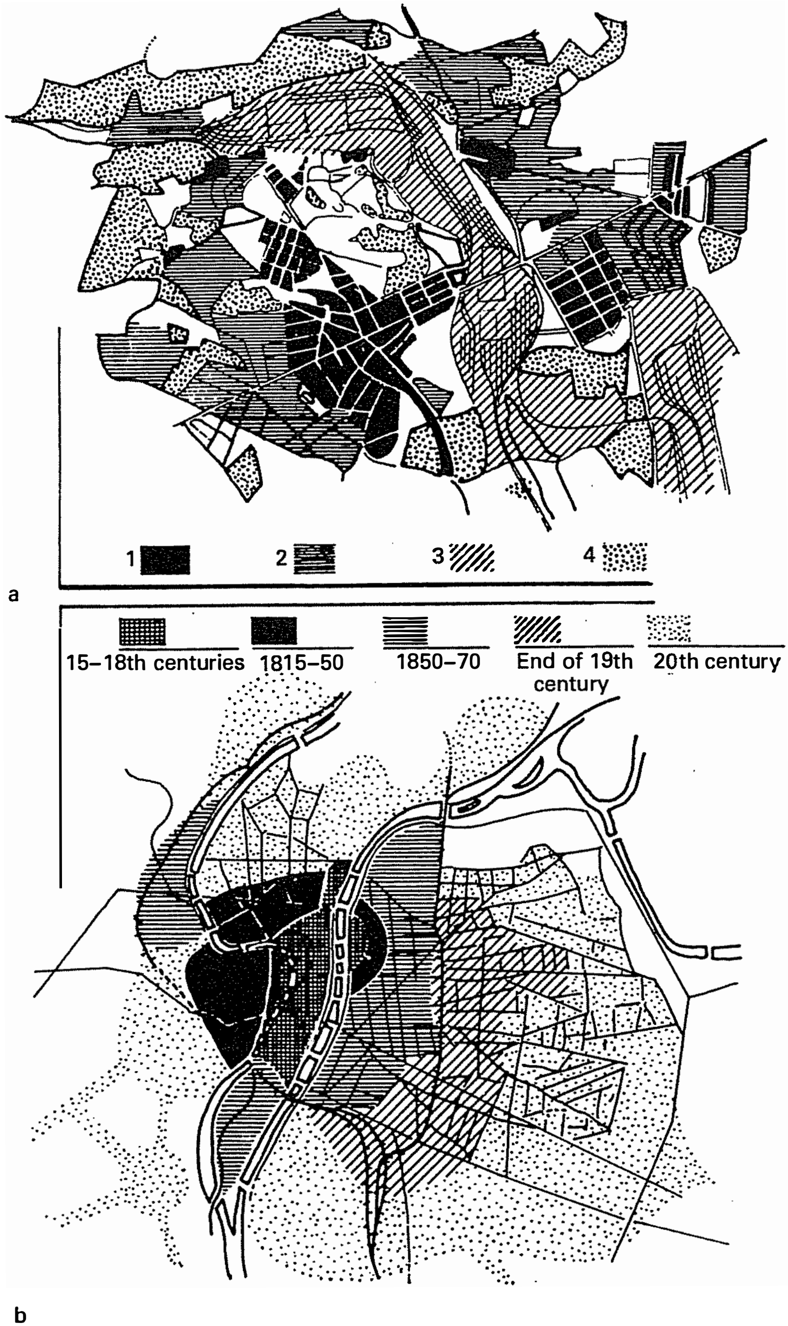
The Breakup of the City

Until the end of the eighteenth century the technical and economic apparatus remained virtually the same as it had been in antiquity. Surrounded by its food-providing countryside, in touch with its rural environment and the world at large through its markets and fairs "outside the walls," the city continued to enclose its merchants and artisans within its ramparts and around its religious and administrative core in a system whose topographical compartmentalization was all the more rigorous as larger numbers of individuals belonging to a wider range of social groups were obliged by constraints of space to rub shoulders with one another. Then a new technoeconomic pattern began to take shape in Europe. Since the Middle Ages the increasing specialization of furnace artisans had caused metallurgical, pottery-making and glassmaking centers to spring up outside the urban system in the great civilizations of Europe and Asia, a development that marked the beginning of a transition from artisanal to preindustrial structures. Pottery still retained its local craft character, but the same was not true of metallurgy, whose growing requirements entailed a concentration of specialists at geographical points with an assured supply of fuel and ore, foreshadowing a new form of social grouping, the industrial city (figures 80 and 81).

It is very difficult to speak of facts so close to contemporary history without seeming to state the obvious, but the decentralization of the iron and steel industry and the rise of cities that had lost all traditional character and were nothing more than agglomerations of workers round their workplace are facts at least as important and interesting as the preeminence of technical specialization in the primitive couple or the bond between farmers and herd breeders in the transition to an agrarian economy. They are all the more important as the industrial revolution was the only major change to occur within agricultural societies in five thousand years. So its repercussions on the social edifice as a whole must be considered comparable to those of the transition to an agrarian economy. Indeed metallurgical decentralization and the establishment of urban units in coal and ore fields led to a complete reappraisal of all existing social structures, including religious ones, within the space of less than a century. The upheavals caused by the industrial revolution are common knowledge. A point worth making is that they were not at odds with but consistent with the functional development of an artificial sociotechnical organism that seems increasingly to reflect properties of the living organism. Another interesting point is that the agrarian problem, as well as the problem of metallurgy, first arose in 3000 B.C.—and did so already in crisis terms. For as long as agricultural societies maintain their original structure, furnace crafts and their successor, industry, will continue to act as the powerful but somehow sinister driving force of material development in the service of a society composed of an ever-increasing number of human beings still governed by the laws of their zoological nature.



80. Functional diagram of a nineteenth-century industrial society. The basis is still the same as in preindustrial times. The capital (a) is divided as in figure 76, but the industrial function is represented by a new group (7) that is connected with the commercial group (5) and has direct contacts with the central authority, whatever the form of government. The agricultural villages, where artisans and small traders are represented, continue to function according to the old system; they are grouped round regional centers (c, d) with their fairs and souks. The difference lies in the establishment of industrial centers (b) connected to the traditional framework by a transport network. Isolated at first because they had to be located close to raw materials and energy sources, industrial centers have proliferated in the vicinity of railways, resulting in the creation of working-class suburbs whose proletarian population no longer fits into the traditional framework.



81. (a) Plan of Le Creusot, France. Note the industrial development along the railway line and the chaotic proliferation of housing areas. (1) Industry, (2) densely built-up area, (3) less densely built-up area, (4) green belt. (b) Gradual spread of the city of Lyons, France. Note the old city built on the banks of the Rhone and Saône rivers, the geometric development in the 1850s and 1870s along the railway line, the irregularly structured late-nineteenth century suburb of Villeurbanne and the sprawl of recent years.

The Present Time

Although the technoeconomic equation has changed in magnitude over the past centuries, its terms still remain the same. The tiny Near Eastern city of the second millennium before our era, with its chiefs, its officials, its group of artisans, its market, its countryside, its flocks, its little wars, its plunders, its tyrannized classes supplying the surplus needed for the development of an apparatus whose rulers, and they alone, indicated the level to which the society had risen—this city of high antiquity can be transposed in unaltered form to any of the great nineteenth-century European states, the only difference being that the surplus now came from distant colonies rather than from peasant serfs just outside the city outskirts. In *Milieu et techniques* I tried to demonstrate the biological consistency of the "the civilized human–the barbarian–the savage" system and the fact that the material progress of humankind still remained tied to that system today. The system is like all living organisms in that it includes apparently privileged elements side by side with obscure masses whose role is to furnish, at the cost of enormous losses, the small reserve impetus needed in order to achieve the transition to the next stage. At the social level this biological truth is expressed in terms of justice and injustice, but that is hardly helpful when it comes to resolving a problem of strictly organic origin.

To what extent does the initial formula still apply? Before the disappearance of the negative constraints imposed by the agricultural–metallurgical technical and economic apparatus became possible, *Homo sapiens* would have to enter upon a new biological stage where perhaps he would be able to control his aggressivity—the factor that, far more than progress, determines justice and injustice. A reduction in aggressive potential, which corresponds to the acquisitive instinct, would of course be reflected in an equivalent lowering of the creative instinct and ultimately of the vital urge: for creation and destruction are but two sides—one bright, the other dark—of the same coin. All the same we may one day break out of the cycle in which society imprisoned itself when humans became their own and practically their only prey. Agriculture and metallurgy may have to give way to a new technoeconomic apparatus whose nature we cannot even guess at today, when the human diet is still based on animal and vegetable matter and metal is still the principal agent of progress. For more than a century socialist ideology has grappled with the problem without, however, exploring all its possible repercussions, which are of particular interest when seen in the general perspective of development. It is a fact that ever since the Upper Paleolithic, but especially since the advent of agriculture, the world of symbols—religious, aesthetic, and social—has always stood higher on the hierarchical ladder than the world of technics. The ambiguity of the social pyramid lies in the fact that symbolic functions enjoy preeminence over technology, although it is the latter that is the driving force behind all progress. Socialist ideology attempts to resolve the problem by subordinating society to technology, thus seemingly acknowledging the triumph of the hand over the head.

But is that really a solution, or is it a dead end? The similar behavior of Marxist and capitalist states in this area strongly suggests that we are indeed moving toward a new solution. It is legitimate to wonder whether the movement is really toward a new balance in which all values will be restored to their proper place in the anthropoid equation, or whether the artificial organism civilization has become is in process of destroying the balance for which the human is physically constituted. In the latter case the hackneyed idea of "man outstripped by his technology" would come strictly true. Even with the help of theoreticians of either ideology, it is difficult to imagine a balance based on indefinitely increasing the material well-being of an indefinitely growing number of individuals. The ratios among production, consumption, and materials suggest that humans are irremediably—though with ever greater efficiency—consuming the materials they derive from the natural environment; in other words, they are consuming their own substance.

Today, despite efforts being made in the social sphere and despite decolonization, the planetary human group still has the same form as the small Mesopotamian societies of four thousand years ago. Whatever the political system in force, the individual is still conditioned by a strictly hierarchical social organization (hereditary or selective) to perform an increasingly narrow function; the world economy still basically rests upon animal and vegetable matter, the only dramatic change being in the technical means employed to obtain it; and industry, successor to the artisan of old, is still based on metals, although its fuels are no longer the same.

Humankind's fabulous triumph over matter has been achieved through a substitution. We have seen how, in the course of anthropoid evolution, zoological balance was gradually replaced by a new balance, perceptible from the very beginnings of *Homo sapiens* in the Upper Paleolithic. The ethnic group—the "nation"—came to replace the species, and the human, whose body is still that of a normal mammal, merged into a collective organism with a practically unlimited potential for achievement. The human internal economy, however, was still that of a highly predatory mammal even after the transition to farming and stockbreeding. From that point on the collective organism's preponderance became more and more imperative, and human beings became the instrument of a technical and economic ascent to which they lent their brains and hands. In this way human society became the chief consumer of humans, through violence or through work, with the result that the human has gradually gained complete possession of the natural world. If we project the technical and economic terms of today into the future, we see the process ending in total victory, with the last small oil deposit being emptied for the purpose of cooking the last handful of grass to accompany the last rat. The prospect is not so much a utopia as the acknowledgment of the singular properties of the human economy, an economy of which nothing as yet suggests that it may one day be properly controllable by the zoological (i.e., intelligent) human. In the last twenty years or so, the consumption ideal has at least been tempered by a growing skepticism about the infallibility of technoeconomic determinism.

6 Language Symbols

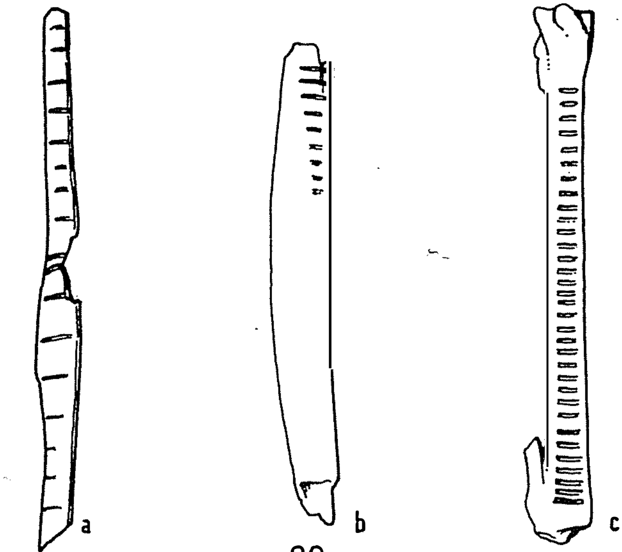
In the preceding chapter we discussed the development of technoeconomic organization and the establishment of social machinery closely connected with the evolution of techniques. Here I propose to consider the evolution of a fact that emerged together with *Homo sapiens* in the development of anthropoids: the capacity to express thought in material symbols. Countless studies have been devoted to, respectively, figurative art and writing, but the links between them are often ill-defined. It has therefore occurred to me that there might be some profit in attempting to analyze those links within a general perspective. In part III we shall consider the aesthetic aspects of rhythms and values, but here, as we near the end of a long reflection principally concerned with the material essence of humans, it may be useful to consider how the system that provides human society with the means of permanently preserving the fruits of individual and collective thought came slowly into being.

The Birth of Graphism

There is a most important fact to be learned from the very earliest graphic signs. In chapters 2 and 3 we saw that the bipolar technicity of many vertebrates culminated in anthropoids in the forming of two functional pairs (hand/tools, face/language), making the motor function of the hand and of the face the decisive factor in the process of modeling of thought into instruments of material action, on the one hand, and into sound symbols, on the other. The emergence of graphic signs at the end of the Palaeoanthropians' reign presupposes the establishment of a new relationship between the two operating poles—a relationship exclusively characteristic of humanity in the narrow sense, that is to say, one that meets the requirements of mental symbolization to the same extent as today. In this new relationship the sense of vision holds the dominant place in the pairs "face/reading" and "hand/graphic sign." This relationship is indeed exclusively human: While it can at a pinch be claimed that tools are not unknown to some animal species and that language merely represents the step after the vocal signals of the animal world, nothing comparable to the writing and reading of symbols existed before the dawn of *Homo sapiens.* We can therefore say that while motor function determines expression in the techniques and language of all anthropoids, in the figurative language of the most recent anthropoids reflection determines graphism.

The earliest traces date back to the end of the Mousterian period and become plentiful in the Châtelperronian, toward 35,000 B.C. They appear simultaneously with dyes (ocher and manganese) and with objects of adornment. They take the form of tight curves or series of lines engraved in bone or stone, small equidistant incisions that provide evidence of figurative representation moving away from the concretely figurative and proof of the earliest rhythmic manifestations. No meaning can be attached to the very flimsy pieces of evidence available to us (figure 82). They have been interpreted as "hunt tallies," a form of account keeping, but there is no substantial proof in the past or present to support this hypothesis. The only comparison that might possibly be drawn is with the Australian churingas, stone or wood tablets engraved with abstract designs (spirals, straight lines, and clusters of dots) and representing the body of the mystic ancestor or the places where the myth unfolds (figure 83). Two aspects of the churinga seem relevant to the interpretation of Paleolithic "hunting tallies": first, the abstract nature of the representation, which, as we shall see, is also characteristic of the oldest known art, and, second, the fact that the churinga concretizes an incantatory recitation and serves as its supporting medium, the officiating priest touching the figures with the tips of his fingers as he recites the words. Thus the churinga draws upon two sources of expression, that of verbal (rhythmic) motricity and that of graphism swept along by the same rhythmic process. Of course my argument is not that Upper Paleolithic incisions and Australian churingas are one and the same thing, but only that among the possible interpretations, that of a rhythmic system of an incantatory or declamatory nature may be envisaged.

If there is one point of which we may be absolutely sure, it is that graphism did not begin with naive representations of reality but with abstraction. The discovery of prehistoric art in the late nineteenth century raised the issue of a "naive" state, an art by which humans supposedly represented what they saw as a result of a kind of aesthetic triggering effect. It was soon realized near the beginning of this century that this view was mistaken and that magical-religious concerns were responsible for the figurative art of the Cenozoic Era, as indeed they are for all art except in a few rare



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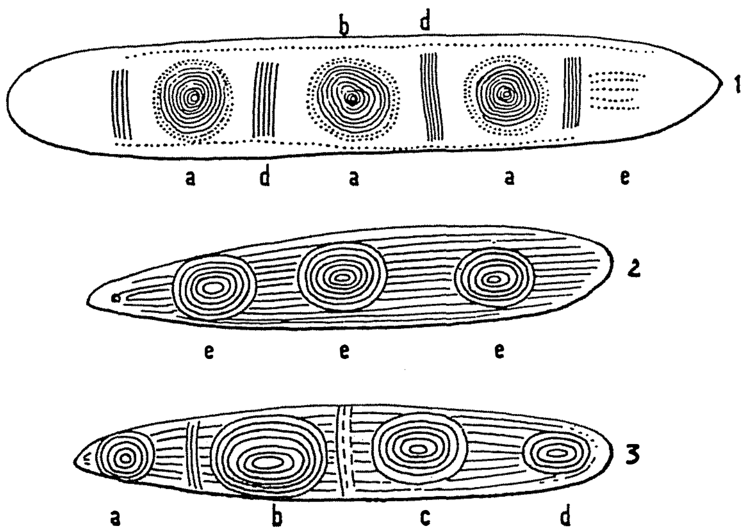

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82. Paleolithic incisions on bone, known as "hunting tallies." (a) *Châtelperronian,* (b) *Aurignacian,* (c) *Solutrean.*

83. Australian churingas (after B. Spencer and F. J. Gillen). (1) Circles represent trees, and dotted circles represent the dancers' steps; lines d *represent rhythmically struck sticks, and* e *the dancers' movements. (2, 3) Churinga of a chief of the honey-ant totem:* (a) *the eye,* (b) *the intestines,* (c) *the paint on the ant's chest,* (d) *the back,* (e) *a small bird, connected with the honey ant. Figure 82 supports the evidence supplied by this figure that representations relating to a verbal and gestural context, like those of the churingas, may be completely lacking in realistic figurative content.*

periods of advanced cultural maturity. However, it was discovered more recently that the Magdalenian records on which the idea of Paleolithic realism is based were produced at what was already a very late stage of figurative art: They date to between 11,000 and 8000 B.C., whereas the true beginning belongs to before 30,000. A fact of particular relevance in our present context is that graphism certainly did not start by reproducing reality in a slavishly photographic manner. On the contrary, we see it develop over the space of some ten thousand years from signs which, it would appear, initially expressed rhythms rather than forms. The first forms, confined to a few stereotyped figures in which only a few conventional details allow us to hazard to identify an animal, did not appear until around 30,000 B.C. All this suggests that in its origins figurative art was directly linked with language and was much closer to writing (in the broadest sense) than to what we understand by a work of art. It was symbolic transposition, not copying of reality; in other words, the distance that lies between a drawing in which a group agrees to recognize a bison and the bison itself is the same as the distance between a word and a tool. In both signs and words, abstraction reflects a gradual adaptation of the motor system of expression to more and more subtly differentiated promptings of the brain. The earliest known paintings do not represent a hunt, a dying animal, or a touching family scene, they are graphic building blocks without any descriptive binder, the support medium of an irretrievably lost oral context.

Prehistoric art records are very numerous, and statistical processing of a large mass of data whose chronological order is more or less definitely established enables us to unravel, if not to decipher, the general meaning of what is represented. The thousand variations of prehistoric art revolve round what is probably a mythological scene in which images of animals and representations of men and women confront and complement each other. The animals appear to form a couple in which the bison is contrasted with the horse, while the human beings are identified by symbols that are highly abstract figurative representations of sexual characteristics (figure 91 and part II, figure 143). Having arrived at such a definition of the content of prehistoric art, we are in a far better position to understand the connection between abstraction and the earliest graphic symbols.

The Early Development of Graphism

Rhythmic series of lines or dots continued to be produced until the end of the Upper Paleolithic. Parallel with these, the first figures begin to appear in the Aurignacian period about 30,000 B.C. They are, to date, the oldest works of art in the whole of human history, and we are surprised to discover that their content implies a conventionality inconceivable without concepts already highly organized by language. The content then is already very complex, but the execution is still rudimentary: In the best samples, animal heads and sexual symbols—already highly stylized—are superimposed on one another pell-mell.

During the next (Gravettian) stage, toward 20,000 B.C., the figures become more deliberately organized. Animals are rendered by the outline of their cervicodorsal curve with the addition of details characteristic of particular species (bison's horns, mammoth's trunk, horse's mane, etc.). The content of the groups of figures remains the same as before, but it is more skillfully expressed. In the Solutrean period, toward 15,000 B.C., engravers or painters are in full possession of their technical resources, which barely differ from those of engravers or painters of today. The meaning of the figures has not changed, and the walls or decorated slabs show countless variations on the theme of two animals and of a man and a woman. However, a curious development has taken place: The representations of human beings seem to have lost all their realistic character and are now oriented toward the triangles, rectangles, and rows of lines or dots with which the walls of Lascaux, for example, are covered. The animals, on the other hand, are developing little by little toward realism of form and movement, although—for all that may have been said and written about the realism of the animals of Lascaux—in the Solutrean they are still far from achieving such realism. In technical skill and mythological content these figures are indeed products of the "Paleolithic Middle Ages," but it would be an error to compare these groups of works to the frescoes of our medieval basilicas or to easel paintings. They are really "mythograms," closer to ideograms than to pictograms and closer to pictograms than to descriptive art.

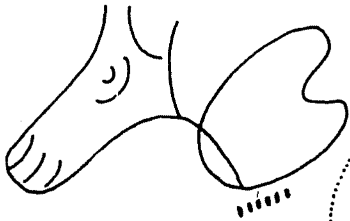
So far as human figures are concerned, the Magdalenian between 11,000 and 8000 B.C.—the period of the great series of cave paintings of Altamira and Niaux—sometimes exhibits a still closer connection with the ideogram and at other times a categorical return to realistic representation. As for the animals, they are swept along on a current in which the artist's skill will eventually (at the time of Altamira) result in a certain academism of form and later, shortly before the end of the period, to a mannered realism that renders movement and form with photographic precision. The art of this later period was the first to become known, thus giving rise to the idea of primitive or "naive" realism.

Paleolithic art, with its enormously long time frame and its abundant records, provides evidence that is irreplaceable for understanding the real nature of artistic figurative representation and of writing: What appear to be two divergent tracks starting at the birth of the agricultural economy in reality form only one. It is extremely curious to find that symbolic expression achieves its highest level soon after its earliest beginnings in the Aurignacian (figures 84 to 87). We see art split away from writing, as it were, and follow a trajectory that, starting in abstraction, gradually establishes conventions of form and movement and then, at the end of the curve, achieves realism and eventually collapses. The development of the arts in historic times has so often followed the same course that we are forced to recognize the existence of a general tendency or cycle of maturation—and also to recognize that abstraction is indeed the source of graphic expression. The question of the return of the arts to abstraction on a newly rethought basis will be discussed in chapter 14, where we shall see that the search for pure rhythmicity, for the nonfigurative in modern art and poetry (born as it was of the contemplation of the arts of living primitive peoples), represents a regressive escape into the haven of primitive reactions as much as it does a new departure.

The Spread of Symbols

As we just saw, figurative art is inseparable from language and proceeds from the pairing of phonation with graphic expression. Therefore the object of phonation and graphic expression obviously was the same from the very outset. A part—perhaps the most important part—of figurative art is accounted for by what, for want of a better word, I propose to call "picto-ideography." Four thousand years of linear writing have accustomed us to separating art from writing, so a real effort of abstraction has to be made before, with the help of all the works of ethnography written in the past fifty years, we can recapture the figurative attitude that was and still is shared by all peoples excluded from phonetization and especially from linear writing.

The linguists who studied the origins of writing often applied a mentality born of the practice of writing to the consideration of pictograms. It is interesting to note that the only true "pictograms" we know are of recent origin and that most of them resulted from contacts between ethnic groups without any writing with travelers or colonizers from countries with writing (figures 88 to 90): Eskimo or Amerindian pictograms are therefore not suitable terms of comparison for acquiring an understanding of the ideograms of peoples who lived before writing was invented. Furthermore the origins of writing have often been linked to the memorization of numerical values (regular notches, knotted ropes, etc.). While alphabetic linearization may indeed have been related from the start to numbering devices which of necessity were lin-



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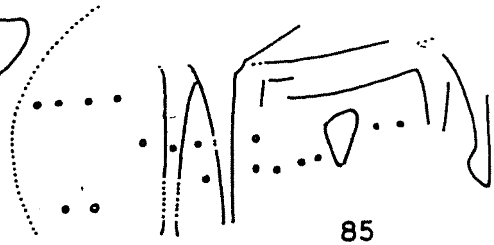

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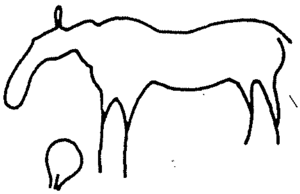

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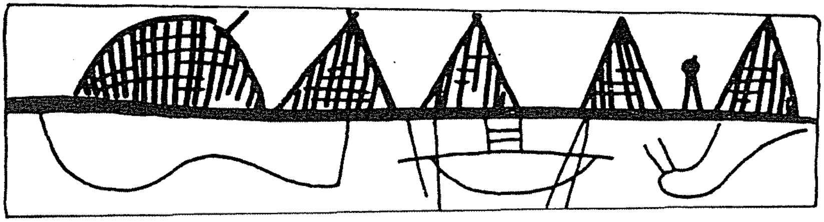
84. Engraving from Aurignacian I, cellier shelter (Dordogne). One of the earliest figurative records that can be dated with certainty. We see a head (probably a horse's), a female symbol, and some regular incisions.

85. Engraving from Aurignacian IV, La Ferrassie (Dordogne), representing an animal (damaged), a female symbol, and some regular rows of points.

86. Engraving, probably Gravettian, Gargas (upper Pyrenees), representing a horse and a female symbol.

87. Magdalenian engraving, Les Combarelles (Dordogne), representing the same subjects. Note that while the theme remains the same, the elements of the mythogram are becoming more realistic.



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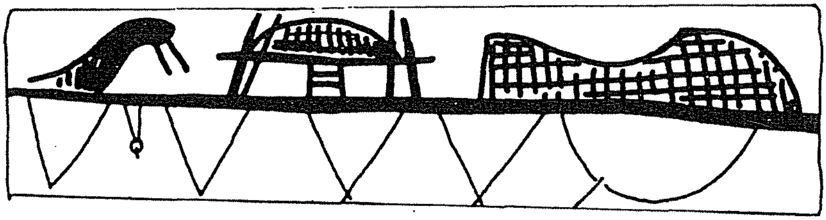

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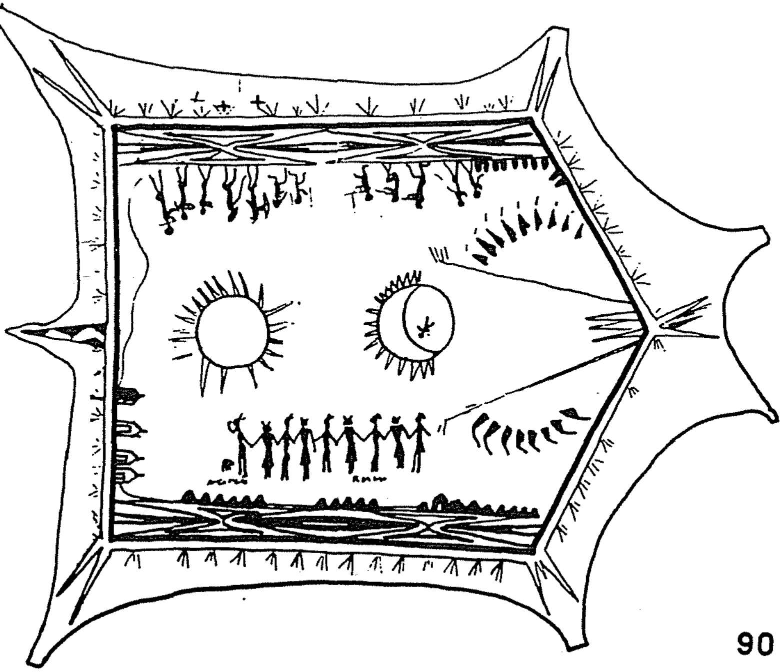

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88–89. Alaskan Eskimo pictogram engraved on an ivory blade, early twentieth century. On one of the sides we see a summer encampment (four tents and a man by a hillock). Turning the platelet over, we see a winter encampment drawn on the same groundline; a sea lion, a skin dinghy turned upside down and a cupola-shaped winter house with a longer covered entranceway. The object was a message left in an abandoned camp to show potential visitors which way to go. Pictograms have been used only by Alaskan Eskimos and only in recent times (nineteenth century).

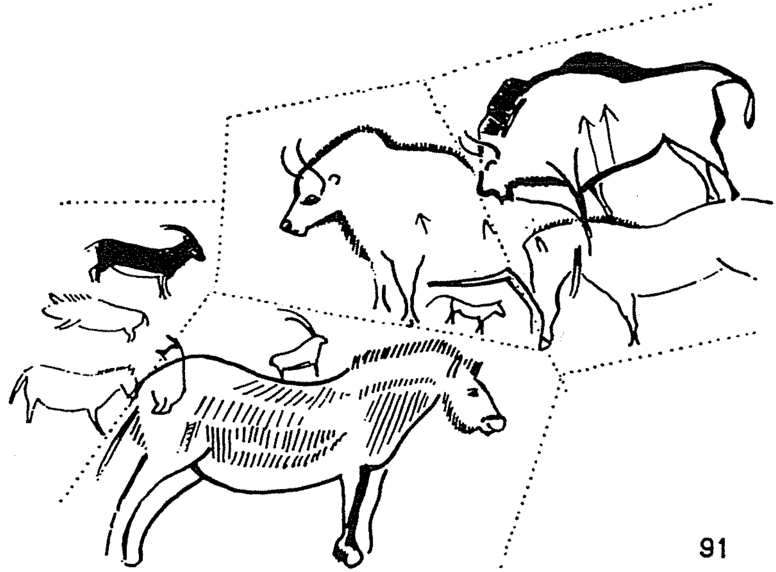
90. Sioux bison skin (late eighteenth century) on which a war expedition is pictographically recounted.

ear, the same is not true of the earliest figurative symboism. That is why I am inclined to consider pictography as something other than writing in its "infancy."

Through an increasingly precise process of analysis, human thought is capable of abstracting symbols from reality. These symbols constitute the world of language which parallels the real world and provides us with our means of coming to grips with reality. By the time of the Upper Paleolithic, reflective thought—which had found concrete expression, probably from the very start, in the vocal language and mimicry of the anthropoids—was capable of representation, so humans could now express themselves beyond the immediate present. Two languages, both springing from the same source, came into existence at the two poles of the operating field—the language of hearing, which is linked with the development of the sound-coordinating areas, and the language of sight, which in turn is connected with the development of the gesture-coordinating areas, the gestures being translated into graphic symbols. If this is so, it explains why the earliest known graphic signs are stark expressions of rhythmic values. Be that as it may, graphic symbolism enjoys some independence from phonetic language because its content adds further dimensions to what phonetic language can only express in the dimension of time. The invention of writing, through the device of linearity, completely subordinated graphic to phonetic expression, but even today the relationship between language and graphic expression is one of coordination rather than subordination. An image possesses a dimensional freedom which writing must always lack. It can trigger the verbal process that culminates in the recital of a myth, but it is not attached to that process; its context disappears with the narrator. This explains the profuse spread of symbols in systems without linear writing. Many authors of works on primitive Chinese culture, Australian aborigines, North American Indians, or certain peoples of Black Africa speak of their mythological way of thinking in which the world order is integrated in an extraordinarily rich system of symbolic relationships. A number of these authors mention the very rich systems of graphic representation available to the peoples they observed. In each case, except perhaps that of the early Chinese where the records postdate the invention of writing, the groups of figures represented are coordinated in accordance with a system that is completely foreign to linear organization and consequently to any possibility of continuous phonetization. The contents of the figures of Paleolithic art, the art of the African Dogons, and the bark paintings of Australian aborigines are, as it were, at the same remove from linear notation as myth is from historical narration. Indeed in primitive societies mythology and multidimensional graphism usually coincide. If I had the courage to use words in their strict sense, I would be tempted to counterbalance "mytho-logy"—a multidimensional construct based upon the verbal—with "mytho-graphy," its strict counterpart based upon the manual.

The forms of thought that existed during the longest period in the evolution of *Homo sapiens* seem strange to us today although they continue to underlie a significant part of human behavior. Our life is molded by the practice of a language whose sounds are recorded in an associated system of writing: A mode of expression in which the graphic representation of thought is radial is today practically inconceivable. One of the most striking features of Paleolithic art is the manner in which the figures on the cave walls are organized (figure 91). The number of animal species represented is small, and their topographic relationships constant: Bison and horse occupy the center of the panel, ibex and deer form a frame round them at the edges, lion and rhinoceros are situated on the periphery. The same theme may be repeated several times in the same cave and recurs in identical form, although with variations, from one cave to another. What we have here therefore is not the haphazard representation of animals hunted, nor "writing," nor "imagery." Behind the symbolic assemblage of figures there must have been an oral context with which the symbolic assemblage was associated and whose values it reproduced in space (figures 92 and 93). The same fact is evident in the spiral figures Australian aborigines draw on sand as symbolic expressions of the unfolding of their myths of the lizard or the honey ant, or in the carved wooden bowls of the Ainus that give material expression to the mythified narration of their sacrifice of the bear (figure 94).

Such a mode of representation is almost naturally connected with cosmic symbolism, and we shall consider its development in chapter 13 in connection with the humanization of time and space. This mode has resisted the emergence of writing, upon which it exerted considerable influence, in those civilizations where ideography has prevailed over phonetic notation (figures 95 to 97). It is still alive in areas of thought that came into being in the early days of linear written expression, and many religions offer many examples of spatial organization of figures symbolizing a "mythological" context in the strict ethnological sense (figure 98). It still prevails in the sciences, where the linearization of writing is actually an impediment, and provides algebraic equations or formulas in organic chemistry with the means of escaping from the constraint of one-dimensionality through figures in which phonetization is employed only as a commentary and the symbolic assemblage "speaks" for itself. Lastly, it reappears in advertising which appeals to deep, infraverbal, states of mental behavior (figure 99).



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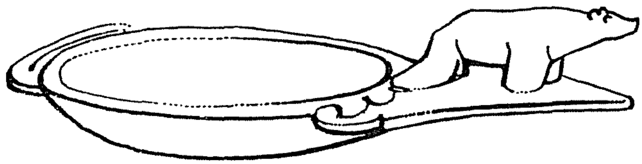
91. Magdalenian mythographic composition, Niaux cave (Ariège). We see an ibex, a bison, and a horse of equal size, a large horse accompanied by a small bison and a small ibex, a large bison with a small horse between its legs, and a bison and horse of equal size; the bisons bear a series of symbolic wounds. A direct reading is impossible because of the composition's mythographic character.

92. Proto-historic rock painting, Val Camonia (Italy), representing a stag accompanied by enigmatic symbols. As with the preceding figure, it is impossible to interpret the meaning without knowing the oral content.

93. Proto-historic figures painted on rock. Val Camonia (Italy). The composition resembles a pictogram by its narrative character (a ploughman followed by other individuals carrying hoes, who are covering up the seeds he has sown), but in contrast to a pictographic series there is no narrative "thread."



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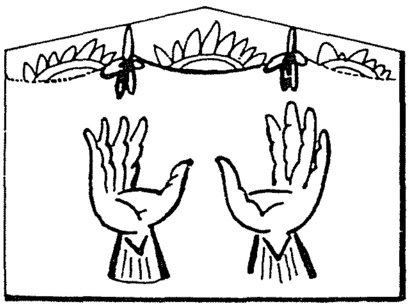

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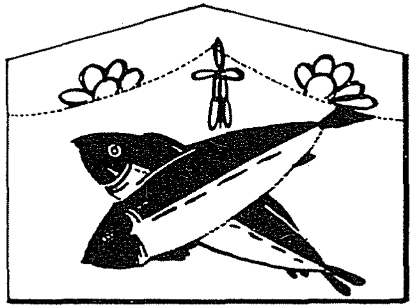

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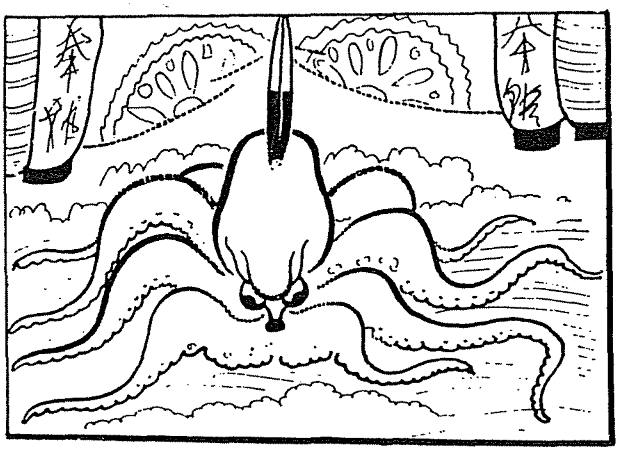

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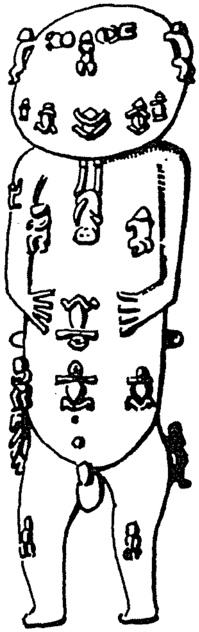
94. Cup commemorating a bear sacrifice, Sakhalin Ainu. Cups were made on the occasion of each bear festival and served as both reminder and record.

95. Ex-voto, Japan. Hand-clapping gesture meant to attract the divinity's attention before making a wish.

96. Ex-voto, Japan. Two tuna (Katṣu-o) *meant to express the concept of "obtaining"* (Katsu).

97. Ex-voto, Japan. Deposited at a temple in the hope of curing a drunkard. The octopus, which turns red when boiled in rice beer, is the symbol of intemperance.



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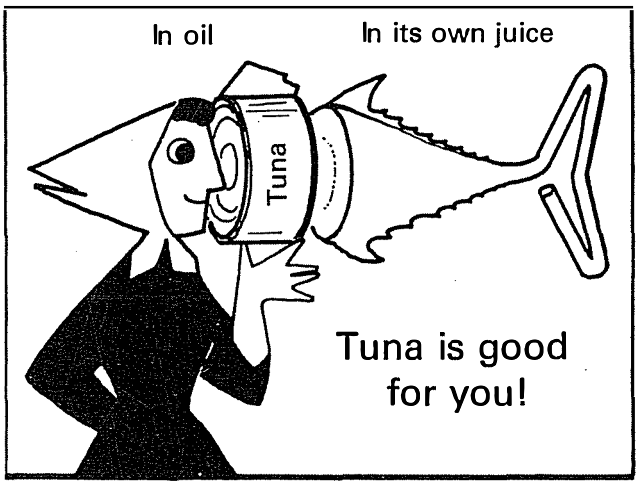

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98. (a) Polynesia, Tubuai. Statuette representing the myth of the creation of gods and humans by the Great Gods of the Ocean. (b) France, sixteenth century. Signs of the zodiac corresponding to parts of the human body.

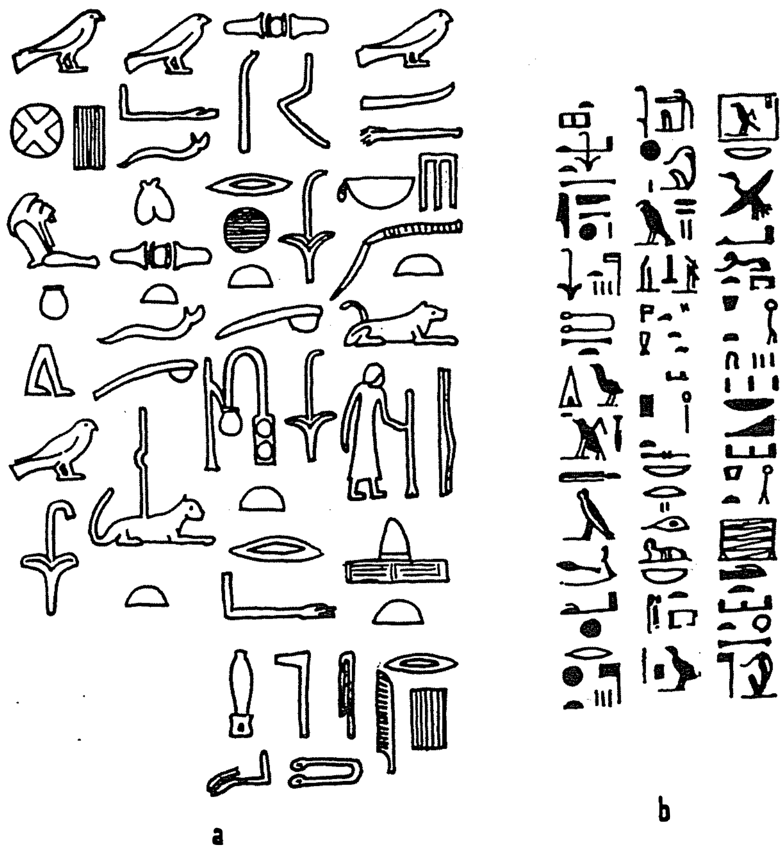
99. Advertising poster showing various figurative symbols (a fishwife, a can of food, a can opener) superimposed on the representation of tuna fish.

Thus the reason why art is so closely connected with religion is that graphic expression restores to language the dimension of the inexpressible—the possibility of multiplying the dimensions of a fact in instantly accessible visual symbols. The basic link between art and religion is emotional, yet not in a vague sense. It has to do with mastering a mode of expression that restores humans to their true place in a cosmos whose center they occupy without trying to pierce it by an intellectual process which letters have strung out in a needle-sharp, but also needle-thin, line.

Writing and the Linearization of Symbols

Only agricultural peoples are known for certain to have had a graphic system even remotely identifiable as linear writing. Eskimos and Plains Indians, often cited as examples to the contrary, created pictographies as a result of exposure to alphabets. The chief distinguishing feature of "mythographic" writing is its two-dimensional structure which puts it at a remove from linearly emitted spoken language. In many nonalphabetic forms of writing, on the other hand, the skeleton of the first system of notation is formed by survivals from the old multidimensional system of figurative representation: This is so for Egypt and China, as well as for the Mayas and the Aztecs. One might be tempted to suppose that these "scripts" had a pictographic origin, with signs for concrete objects such as an ox or a walking man being aligned one after the other to reproduce the linear thread of language. Except for some bookkeeping enumerations in proto-historic China or in Near Eastern tablets, there in fact is no known pictographic evidence of the origins of writing. From groups of mythographic figures—simple "rock paintings" or decorations on objects—we go straight to linearized symbols already fully set upon the process of phonetization.

The pictographic hypothesis presupposes a "cold" start, an initial idea of aligning images in such a way as to match the thread of spoken language. It would be acceptable if no other symbolic system had existed previously, but may prove false if we apply the "favorable circumstances" rule and posit that what took place did not do so all at once but represented a transition. Writing did not happen in a void any more than did agriculture. The stages that precede both have to be taken into account. At a certain moment in time, which was not the same moment in different parts of the world, the system of organized representation of mythical symbols appears to have combined with the system of elementary bookkeeping (figure 100), the result being the primitive Sumerian or Chinese writing in which images borrowed from the regular repertory of figurative representation were drastically sim-



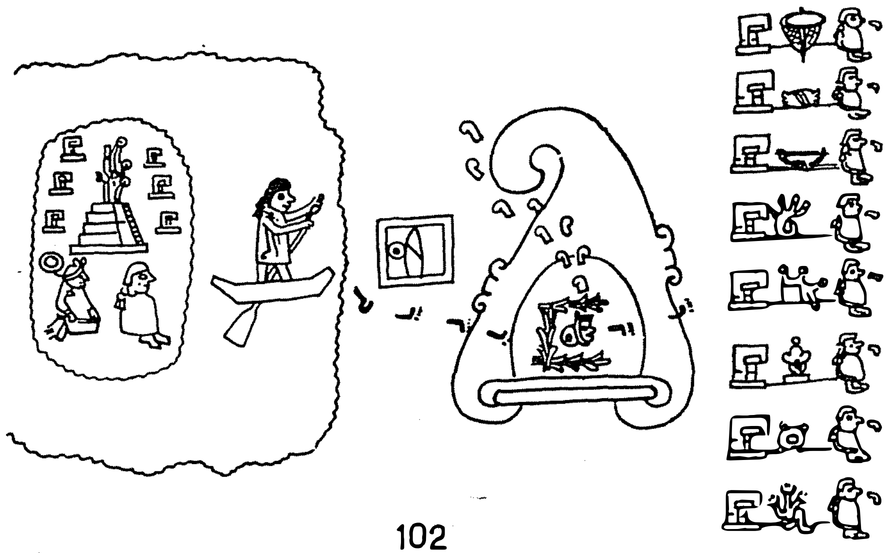
100. Egyptian hieroglyphics of (a) *the fourth and* (b) *the twenty-first dynasties. Note the developed linearization of the more recent phonetic symbols.*

plified and arranged to form a sequence. The procedure did not yet produce any actual texts but helped to keep count of animals or objects. The simplification of the figures, necessitated by the nonmonumental, provisional nature of the records, was responsible for their gradually becoming detached from the initial material context. From being symbols with extensible implications, they developed into signs, genuine tools in the service of memory, on the one hand, and bookkeeping, on the other.

Preparation of written bookkeeping or genealogical accounts is foreign to the primitive social apparatus. Not until the consolidation of urbanized agricultural societies did social complexity begin to be reflected in documents whose authenticity was attested by humans or by gods. Whereas we can conceive of a bookkeeping system in which figures and simplified drawings of animals or measures of grain are sequentially aligned, it is difficult to imagine linearized pictographic signs expressing actions (rather than objects) from which the phonetic element has been entirely excluded. The "mythogram" in fact is already an ideogram, as we must realize if we look at such traces as still survive today: A cross next to a lance and a reed with a sponge on the end of it are enough to convey the idea of the Passion of Christ. The figure has nothing to do with phoneticized oral notation, but it has an extensibility such as no writing can have. It contains every possibility of oral exteriorization, from the word "passion" to the most complex commentaries on Christian metaphysics. Ideography in this form precedes pictography, and all Paleolithic art is ideographic.

A system in which three lines are followed by a drawing of an ox or seven lines by a drawing of a bag of corn is also readily conceivable. In this case phonetization is spontaneous, and reading becomes practically inevitable. This form of pictography is probably the only one that existed at the time of the birth of writing, and writing was bound to merge immediately with this preexisting ideographic system. The spontaneous confluence of the two would explain why the earliest forms of Mediterranean, Far Eastern, and American writing begin with numerical or calendar notations and, at the same time, with notations of the names of gods or of distinguished individuals in the form of figures assembled in small groups after the fashion of successive mythograms. We think of Egyptian, Chinese, and Aztec writing as lines of phoneticized mythograms rather than as aligned pictograms (figures 100 to 102). Most recent authors have been well aware of the difficulty of fitting the pictographic stage into the development of phoneticized writing, but they do not seem to have perceived the connection between very early mythographic notation systems, which implies an ideography without an oral dimension and a form of writing whose phonetization apparently began with numbers and quantities.

101



102

101. Mayan manuscript. Fragment of a figurative representation of ceremonies to mark the beginning and end of a year. Lines of numerical signs and mythographic figures are integrated in the same composition.

102. Figurative manuscript representation of the beginning of the Aztec migration. From left to right: *(1) Seated on an Aztlan island his personification and, in hieroglyphics, the six tribes. (2) The Aztecs cross the water. (3) The date (inside a rectangle). (4) A march, represented by a footprint, leads to the city of Colhuacan, represented by its hieroglyphic. (5) Eight other tribes, representing by the hieroglyphic for a man talking. This inscription is a succession of partially phoneticized mythograms connected to one another by a pictographic thread.*

Chinese Writing

For all the variety of known phonetic scripts, the number of scripts that developed into fully elaborated phonetic systems is very limited. Those of America disappeared before they had a chance to develop beyond the earliest stages. The writing of the Indus has no known descendants. Once the Near Eastern group of scripts had been created, there was no further reason, save very exceptionally, for any fresh departures, and the languages of Eurasia moved directly to syllabic or consonantal scripts or to alphabets. Only Egypt and China remained as the two poles of the ancient civilizations to develop phoneticized ideographic systems. Since the seventh century B.C. Egyptian writing has lost much of its archaicism, and China alone has maintained until the present day a system of graphic symbols that has more than one dimension.

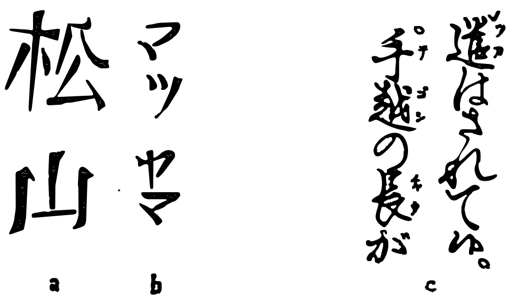
The Chinese system combines the two contrasting aspects of graphic notation (figure 103). It is a script in the sense that each character contains the elements of its phoneticism and occupies a position in a linear relationship with other characters so that sentences can be read easily. The phonetic reference of the word, however, is an approximation. In other words, an ideogram now used only to represent a sound—a stage that alphabetic languages too went through at one time. Chinese as a phonetic tool corresponds approximately, though with greater subtlety, to a graphic pun or rebus whereby the word "rampage," say, might be rendered by the signs for "ram" and "page." Imperfect as it is, this tool has, because of the multiplicity of its signs, proved a satisfactory means of language notation. We should note, however, that oral tradition is there to ensure phonetic continuity: Without it, Chinese characters would become hopelessly unpronounceable, even if recordings of the spoken language were available. Be that as it may, Chinese writing in its phonetic role complies with the rule that governs all writing by recording sounds in an order that reconstitutes the flow of spoken language.

From the linguistic point of view, Chinese is regarded as word writing, each sign representing the sound of a word rather than a letter. This is an ambiguous situation because the Chinese word has changed over the centuries from being polysyllabic to being monosyllabic, with the following results: (1) Chinese literary writing is practically a series of syllable-words, difficult to understand without visually or mentally reading the signs that correspond to them, and (2) in the joining together of monosyllables, the spoken language has reconstituted a large number of disyllabic or trisyllabic words so that the written notation of the spoken language is, in the final analysis, a syllabic script. In both of these aspects Chinese clearly demonstrates that writing was born of the complementary interaction of two systems: "mythograms" and phonetic linearization. The somewhat strained and often laborious, but ultimately successful, adaptation of Chinese writing to phoneticism has resulted in preserving a particular form of mythographic notation rather than simply the remote memory of a "pictographic" stage.

The earliest Chinese inscription (twelfth and eleventh centuries B.C.), like the first Egyptian inscriptions and Aztec glyphs, have come to us in the form of figures assembled in groups that provide the object or action they describe with a "halo" much wider than the narrow meaning words have assumed in linear writing. To write the words *an* ("peace") or *chia* ("family") in letters is to state the two concepts reduced to their skeleton: To convey the idea of peace by representing a woman under a roof opens up perspectives that are, properly speaking, "mythographic" in that the sign is neither a transcription of a sound nor a pictographic representation of an action or a quality but an assemblage of two images whose interplay reflects the full depth of their ethnic context. This becomes still more patently evident when we see that an assemblage composed of the signs for "roof" and "pig" stands for "family," a foreshortened image with the whole technoeconomic structure of ancient China for its background.

One might see little difference between such writing and pictography in the sense of a succession of drawings showing actions or objects wholly outside a phonetic context. Chinese writing may seem to come close to this definition because of its basic principle, which is that one-half of each character is "pictographic" and the other phonetic. But to see in the Chinese character nothing more than a category indicator (the radical) stuck on to a phonetic particle would be an unwarranted restriction of its meaning. We need only take a modern example like the word "flashlight" to realize how flexible the images still are (figures 103 and 104). To the speaker, *tien-ch'i-teng* means "flashlight" and nothing else. But to the attentive reader, the juxtaposition of the three characters for "lightning", "steam," and "lamp" opens a whole world of symbols that form a halo round the banal image of the flashlight: lightning issuing forth from a rain cloud, for the first; steam rising over a pan of rice, for the second; and fire and a receptacle, or fire and the action of rising, for the third. Parasitic images, no doubt, and likely to cause the reader's thoughts to stray in a manner irrelevant to the real object of notation, worthless images, indeed, in the context of a modern object—yet even an example as commonplace as this gives us an inkling of a mode of thought based on diffuse multidimensional configurations rather than on a system that has gradually imprisoned language within linear phoneticism.

103



104

103. Chinese writing. (a) Archaic and modern graphic signs for a skein of fiber (pictograms). (b) A skein and the sign (archaic and modern) for a shuttle: When assembled they signify "order" or "succession" (ideogram). (c) The skein and the sign chih. *The pictographic element has a classificatory function (the concept of "fibers"), the other element being the purely phonetic* chih *("paper"). (d) Archaic graphic sign for "roof." (e) Roof + woman = peace. (f) Roof + fire = disaster. (g) Roof + pig = domestic arrangements, fam-*

It is interesting to note that in a sense the combination of ideographic with phonetic notation in ideograms emptied of their meaning has deepened the role of mythographic notation in the Chinese language by deviating it from its course. It has created a highly symbolized relationship between the sound that is noted (auditive poetic matter) and its notation (a swarm of images), thus offering Chinese poetry and calligraphy their superb possibilities. The rhythm of the words is counterbalanced by that of the subtly interrelated lines, creating images in which each part of each character, as well as the relationship of every character to every other, sparkles with allusive meaning.

The two aspects—ideographic and phonetic—of Chinese writing are so mutually complementary and, at the same time, so foreign to one another that each has engendered separate different notation systems outside China. The manner in which Chinese writing was borrowed by the Japanese is difficult to describe in terms comprehensible to a European mentality (figures 104 and 105). The two languages are much further removed from one another than Latin is from Arabic, and the manner in which Chinese writing fits Japanese spoken language is something like trying to write French by selecting from among postage stamps the picture that approximately corresponds to the meaning of the words to be transcribed, and assembling them in rows: Both grammar and the phonetic content are completely lost. The characters were borrowed at a strictly ideographic level, with Japanese phoneticism expressed by signs emptied of their sound in Chinese, much as the phoneticism of the figure 3 is different in every language. Here, however, the borrowing does not involve a mere ten signs, as in our numerical system, but thousands of signs, ultimately expelling the sound matter of language from the scope of writing. As for the ideological matter, it is confined to concepts, grammatical inflexions being completely left aside and unaccounted for. To compensate for this shortcoming, the Japanese language borrowed from the Chinese, in the eighth century A.D., forty eight characters that are used exclusively for their phonetic value, and from these it has created a syllabic notation register that has inserted itself between the ideograms. In consequence, the Chinese system of writing composed of multidimensional elements, each group forming a character contains the means whereby it can be ren-

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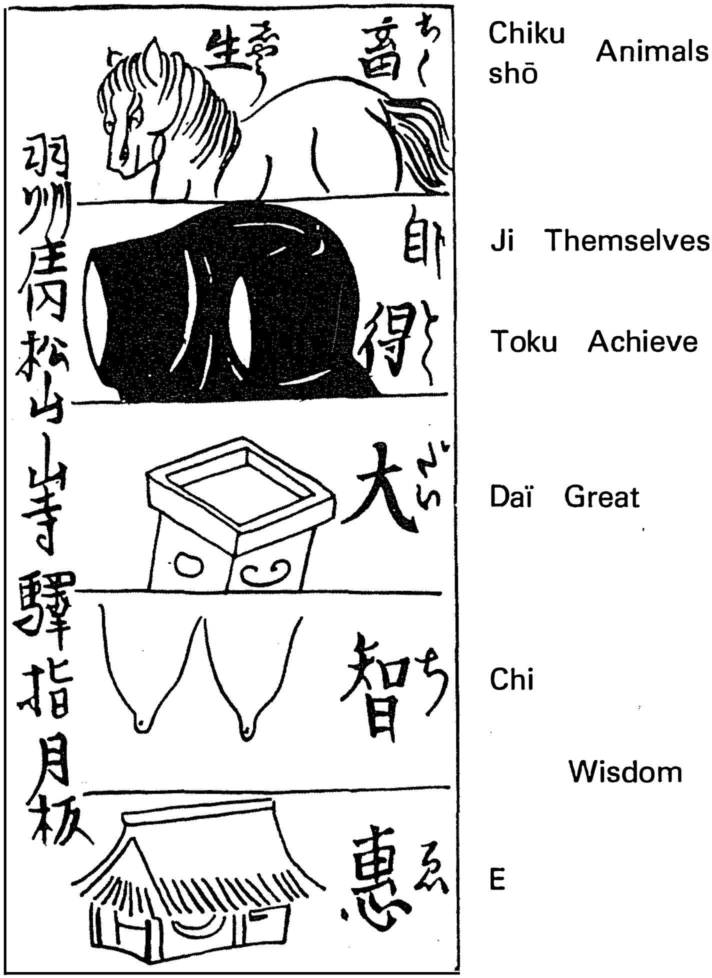
ily. (h, i, j) tiench'i teng: *electric bulb.* Tien: *thunder = rain, lightning,* ch'i *steam = cloud, rice;* teng: *lamp = fire + mount + pedestal.*

104. Japanese writing. (a) Two Chinese characters: sung-shen, *"mountain of pines." (b) Japanese reading:* matsu-yama, *expressed in syllabic characters. (c) Fragment of a dramatic text including Chinese characters held together by a syntactic "binder" in cursive syllabic characters and annotated by phonetic elements.*



105. Fragment of a popular Buddhist text including: (a) *Japanese phonetic notation:* chiku-shō *("animals"),* ji *("themselves"),* toku *("achieve"),* da'i *("great"),* chi-e *("wisdom").* (b) *The seven Chinese characters corresponding to the phoneticized test.* (c) *Drawings representing an animal* (shō), *an eiderdown* (toku), *a tray* (dai), *a pair of breasts* (chi), *and a house* (e), *which approximately reconstitute the text.*

dered phonetically, Japanese first stripped the characters of their phonetic coloring and then attached a distinctive phonetic sign to each one.

The Chinese system, like the Japanese, is said to be "impractical" and ill-suited for the purpose of translating spoken language into graphic terms. This is true only to the extent that writing is viewed as an economical method of transcribing narrow but precise concepts—an object achieved most efficiently by linear alignment. The language of science and technology meets such a definition, and alphabets meet its requirements. It seems to me that other procedures for expressing thought should not be overlooked, and in particular those that reflect the flexibility of images, the halo of associations, and all the complementary or conflicting representations that gravitate round the central point of a concept. Chinese writing represents a state of balance unique in human history: Whatever one may say, it renders mathematical or biological concepts faithfully enough, while still preserving the possibility of using the oldest system of graphic expression—the juxtaposing of symbols to create, not sentences, but meaningful groups of images.

Linear Graphism

There is no need here to go into the details of the history of linear writing. The Sumero-Accadian scripts, which before 3000 B.C. already contained a very large number of ideograms in process of development toward phonetic transcription, were followed by consonantal scripts, of which the Phoenician (around 1200 B.C.) is the earliest example, and later by the Greek alphabet of the eighth century B.C. This continuous development included every possible stage—from realistic representation of an object to render the word for that object, through the same representation to render the equivalent sound in other words according to the principle of the picture puzzle, through the process of simplification whereby the object is made unidentifiable and becomes a purely phonetic symbol, to assembling discrete symbols in order to transcribe sounds through the association of letters. The development has been described many times; it is regarded as the glory of the great civilizations, and rightly so for it was this development that put them in possession of the means for their ascent.

There indeed is a direct link between the technoeconomic development of the Mediterranean and European group of civilizations and the graphic tool they perfected. We saw earlier that the role of the hand in toolmaking counterbalanced the role of the facial organs in creating verbal language; we also saw that at a certain moment just before the emergence of *homo sapiens,* the hand began to play a part in creating a graphic mode of expression that counterbalanced verbal language. The hand thus became a creator of images, of symbols not directly dependent on the progression of verbal language but really parallel with it. The language that, for lack of a better term, I have called "mythographic" because the mental associations it arouses are of an order parallel to that of verbal myths, both lying outside the scope of strict coordinates in space and time, belongs to this period. Writing in its earliest phase preserved a great deal of this multidimensional vision; it continued to suggest mental images that, though not imprecise, were "haloed" and could point in several divergent directions. Although our anatomical evolution had been overtaken by the evolution of technical means, the global evolution of humankind remained perfectly consistent with itself. The brain of the man of Cro-Magnon may have been as good as ours—at any rate, there is nothing to prove the contrary—but his means of expressing himself were far from equal to his neuronal apparatus. The greatest development has been in the means of expression. In primates the actions of the hands are in balance with those of the face, and a monkey makes wonderful use of this balance. It even goes so far as to make its cheeks serve to carry food, which its hands, still required for walking, cannot do. In early anthropoids a kind of divorce takes place between the hand and the face. Thereafter the one contributes to the search for a new balance through gesticulation and tools, the other through phonation. With the emergence of graphic figurative representation, the parallelism is reestablished. The hand has its language, with a sight-related form of expression, and the face has its own, which relates to hearing. Between the two is the halo that confers a special character upon human thought before the invention of writing proper: The gesture interprets the word, and the word comments upon graphic expression.

At the linear graphism stage that characterizes writing, the relationship between the two fields undergoes yet another development: Written language, phoneticized and linear in space, becomes completely subordinated to spoken language, which is phonetic and linear in time. The dualism between graphic and verbal disappears, and the whole of human linguistic apparatus becomes a single instrument for expressing and preserving thought—which itself is channeled increasingly toward reasoning.

The Constriction of Thought

The transition from mythological to rational thinking was a very gradual shift exactly synchronous with the development of urban concentrations and of metallurgy. The earliest beginnings of Mesopotamian writing date back to about 3500 B.C., some 2,500 years after the appearance of the first villages. Two thousand years later, toward 1500 B.C., the first consonantal alphabet appeared in Phoenicia, toward 750 B.C. alphabets were being used in Greece, and by 350 B.C. Greek philosophy was advancing by leaps and bounds.

Available evidence of the organization of primitive thought is difficult to interpret, either because it comes to us from very fragmentary prehistoric evidence or because our records about the thinking of Australian aborigines or Bushmen have been filtered by ethnographers who did not always take the trouble to analyze them. What we do know suggests a process wherein contradictions between different values are ordered within a participatory logic that at one time gave rise to the concept of "pre-logical" reasoning. Primitive thought appears to take place within a temporal and spatial setting which is continually open to revision (see chapter 13). The fact that verbal language is coordinated freely with graphic figurative representation is undoubtedly one of the reasons for this kind of thinking, whose organization in space and time is different from ours and implies the thinking individual's continuing unity with the environment upon which his or her thought is exercised. Discontinuity begins to appear with agricultural sedentarization and with early writing. The basis now is the creation of a cosmic image pivoted upon the city. The thinking of agricultural peoples is organized in both time and space from an initial point of reference—*omphalos*—round which the heavens gravitate and from which distances are ordered. The thinking of pre-alphabetic antiquity was radial, like the body of the sea urchin or the starfish. It only just began to master rectilinear progression in archaic forms of writing, whose means of expression were still very diffuse except for the purposes of account keeping. The process of the world's subsequent imprisonment in the toils of "exact" symbols had barely begun, and the summit of perfection in the handling of mythological thought was reached in the Mediterranean or in the China of the first millennium before our era. It was a time when the vault of heaven and the earth were joined together within a network of unlimited connections, a golden age of prescientific knowledge to which our memory still seems to hark back nostalgically today.

The process set in motion by settled agriculture contributed, as we have seen, to putting the individual more and more firmly in control over the material world. This gradual triumph of tools is inseparable from that of language—indeed the two phenomena are but one, just as technics and society form but one subject. As soon as writing became exclusively a means of phonetic recording of speech, language was placed on the same level as technics; and the technical efficacy of language today is proportional to the extent to which it has rid itself of the halo of associated images characteristic of archaic forms of writing.

Writing thus tends toward the constriction of images, toward a stricter linearization of symbols. For classical as well as modern thinking, the alphabet is more than just a means of committing to memory the progressive acquisitions of the human mind; it is a tool whereby a mental symbol can be noted in both word and gesture by a single process. Such unification of the process of expression entails the subordination of graphism to spoken language. It avoids the wastefulness of symbols that is still characteristic of Chinese writing, and it parallels the process adopted by technics over the course of its development.

However, it also entails an impoverishment of the means of nonrational expression. If we take the view that the course humankind has followed thus far is wholly favorable to our future—if, in other words, we have complete confidence in settled agriculture and all its consequences—then we should not view the loss of multidimensional symbolic thought otherwise than we do the improvement achieved in the running ability of Equidae consequent upon the reduction of the number of their digits to one. But if, conversely, we tend to believe that human potentiality would be more fully realized if we achieved a balanced contact with the whole of reality, then we may ask ourselves whether the adoption of a regimented form of writing that opened the way to the unrestrained development of technical utilitarianism was not a step well short of the optimum.

Beyond Writing: The Audiovisual

With alphabetic writing, a certain level of personal symbolism is still preserved. The reconstruction that the eye performs in reading the written word is still an individual one. There is a margin which, though limited, is indisputably present, and it ensures a personal interpretation of phonetic matter. Moreover the images evoked by reading remain the property of the reader's imagination, which may or may not be very rich. When it replaced ideographic symbols by letters—when, as it were, it changed levels—the alphabet did not abolish all possibilities of recreation. To put it differently, alphabetic writing, while meeting the needs of social memory, still allows the individual to reap the benefits of the interpretative effort he or she has to make.

We could ask ourselves whether, despite the current vast increase in the output of printed matter, the fate of writing is not already sealed. The emergence of sound recording, films, and television in the past half-century forms part of a trajectory that began before the Aurignacian. From the bulls and horses of Lascaux to the Mesopotamian markings and the Greek alphabet, representative signs went from mythogram to ideogram and from ideogram to letter. Material civilization rests upon symbols in which the gap between the sequence of emitted concepts and their reproduction has become ever more narrow. This gap or interval is narrowed still further by the recording of thought and its mechanical reproduction. We might wonder what the consequences of this narrowing will be. Curiously enough, the mechanical recording of images has, in less than a century, covered the same ground as the recording of the spoken word did over several thousands of years. First, two-dimensional visual images became automatically reproducible through photography. Then, as with writing, came the turn of the spoken word, reproduced by means of the phonograph. Up to that point the mechanism of mental assimilation had remained undistorted: Photography, being purely static and visual, left as much room for freedom of interpretation as the bisons of Altamira had left to the humans of the Paleolithic. The auditive sequence imposed by the phonograph likewise allowed room for personal and free mental vision.

This traditional state of affairs was not appreciably altered by the arrival of silent films. The silent reel was supported by sound ideograms of an indeterminate nature supplied by a musical accompaniment that maintained a distance between the individual and the image imposed from the outside. A radical change occurred, however, with the coming of sound film and television, both of which address the faculties of sight, motion, and hearing at the same time and so induce the whole field of perception to participate passively. The margin for individual interpretation is drastically reduced because the symbol and its contents are almost completely merged into one and because the spectator has absolutely no possibility of intervening actively in the "real" situation thus recreated. The spectator's experience is different from a Neanderthalian's in that it is purely passive, and different from a reader's in that it is totally *lived* through both sight and hearing. From this dual point of view, audiovisual techniques really seem to represent a new stage of human development—a stage that has direct bearing on our most distinctive possession, that of reflective thought.

From the social point of view, the audiovisual indisputably represents a valuable gain inasmuch as it facilitates the transmission of precise information and acts upon the mass of people receiving it in ways that immobilize all their means of interpretation. In this respect language follows the general evolution of the collective superorganism and reflects the increasingly perfect conditioning of its individual cells. Can a genuine return by the individual to earlier stages of figurative representation still be envisaged? Writing is unquestionably a most efficient adaptation of audiovisual behavior, which is our fundamental mode of perception, yet it is also a very roundabout way of achieving the desired effect. The situation now apparently becoming generalized may therefore be said to represent an improvement in that it eliminates the effort of "imagining" (in the etymological sense). But imagination is the fundamental property of intelligence, and a society with a weakened property of symbol making would suffer a concomitant loss of the property of action. In the modern world the result is a certain imbalance, or rather a tendency toward the same phenomenon as that taking place in the arts and crafts: the phenomenon of loss of the exercise of the imagination in vital operating sequences.

Audiovisual language tends to concentrate image making entirely in the minds of a minority of specialists who purvey a completely figurative substance to the individual. Image makers—painters, poets, or technical narrators—have always, as far back as in the Paleolithic, been a social exception, but their work always remained incomplete because it called for the participation of the image users, whatever their cultural levels. Today a separation (extremely profitable to the collective) is in process of being wrought between a small elite acting as society's digestive organ and the masses acting purely as its organs of assimilation. This development is not confined to the audiovisual media, which are merely the end point of a general process that involves the whole of human graphic activity. Photography did not at first cause any change in the intellectual perception of images; like all innovations, it was supported by what already existed. Just as the first motor cars were horseless carriages, so the first photographs were portraits and scene paintings without color. The process of "predigestion" did not begin until the emergence of cinematography, which completely changed the concept of photography and drawing in the purely pictographic sense. The sports photograph and the comic strip, together with the "digest," have also contributed to separating the image maker from the image consumer within the social organism.

The impoverishment is not in the themes but in the loss of personal imaginative versions. The number of themes in popular (as indeed in highbrow) literature has always been limited, so there is nothing extraordinary about seeing the same very handsome and exceptionally strong superman, the same amazingly attractive woman, and the same more or less stupid giant appear successively in the midst of Sioux Indians and bisons, in a pitched battle during the Hundred Years' War, on board a pirate ship, in a police car roaring off in pursuit of gangsters, or in a space rocket traveling between two planets. Endless repetition of an unchanging stock of images goes hand in hand with the tiny amount of free space that the exercise of emotions related in one way or another to aggressivity or sexuality leaves in the individual consciousness. That the comic strip's ability to render action in a convincing manner is far greater than the old "penny dreadful's is not in doubt: In the latter a punch in the face was an incomplete symbol, whereas Superman's left hook to the traitor's jaw leaves nothing to be added by way of traumatic precision. Everything assumes a totally naked reality, to be absorbed without the least effort, the recipient's brain perfectly slack.

In this first part of the book language has been considered on the same footing as technics, from an entirely practical point of view and as a product of the biological entity called the "human being." The initial balance between the two poles of the field of responsiveness connects our evolution with that of all animals in which the performance of operations is divided between the face and the forelimb. But by implication it also connects the existence of language with that of manual techniques. What we know about the evolution of the brain allows us—so far as new techniques are concerned—to analyze the connection between erect posture, the freeing of the hand, and the opening up of areas of the brain that were the preconditions for the exercise of physical abilities, on the one hand, and the development of human activity on the other. The proximity, inside the brain, between the two manifestations of human intelligence is so striking that despite the lack of fossil evidence, we must accept that human language was from the very outset different in nature from the language of animals—that it was the product of reflection between the two mirrors of technical gesture and phonic symbolism. This hypothesis concerning humans who existed before *Homo sapiens*—humans going as far back as the remotest Australanthropians—becomes a certainty when we discover the close synchronism between the evolution of techniques and that of language. The certainty is confirmed when we see how closely, even for the very purpose of expressing thought, hand and voice remain intimately linked.

Parallel with the extraordinary acceleration of the development of material techniques following the emergence of *Homo sapiens,* the abstract thought we find reflected in paleolithic art implies that language too had reached a similar level. Graphic or plastic figurative representation should therefore be seen as the means of expression of symbolic thinking of the myth-making type, its medium being graphic representation related to verbal language but independent from phonetic notation. Although no fossil records of late Paleolithic languages have come down to us, evidence fashioned by the hands of humans who spoke those languages clearly suggests that their symbolizing activities—inconceivable without language—were on a level with their technical activities, which in turn are unimaginable without a verbalized intellectual supporting structure.

The parallelism continued at every stage: When agricultural sedentarization gave rise to a hierarchical and specialized social system, a fresh impetus was imparted simultaneously to technics and language. If the topographical structure of the cerebral cortex of primitive anthropoids accommodated the joint development of the material and the verbal, the topographical structure of the urban superorganism reflected the same contiguousness. When the economic system became transformed into capitalism based on metallurgy and grain, the transformation engendered both science and writing. When techniques within the city walls began to prepare the ground for the world of today, when space and time became organized within a geometrical network that captured both the earth and the heavens, then rationalizing thought began to overtake mythical thought. Symbols were linearized and gradually adapted to the flow of verbal language until graphic phonetization finally culminated in the alphabet. From the beginning of written history, as in still earlier times, there has been a complete reciprocal linkage between technics and language, and the whole of human development depends upon this fact. The expression of thought through language found an instrument with infinite possibilities in the use of alphabets, which totally subordinated the graphic to the phonetic. All previous forms remain alive, however, although to varying degrees. Further on in this book we shall try to demonstrate that a significant portion of our thought diverges from linearized language in the effort to grasp that which does not lend itself to strict notation.

Although the interplay between the two poles of figurative representation—between the auditive and the visual—changed considerably with the adoption of phonetic scripts, the individual's capacity to visualize the verbal and the graphic remained intact. The present stage is characterized simultaneously by the merging together of the auditive and the visual, leading to the loss of many possibilities of individual interpretation, and by a social separation between the functions of symbol making and of image receiving. Here again the parallelism between technics and language is clearly apparent. Tools detached themselves from the human hand, eventually to bring forth the machine: In this latest stage speech and sight are undergoing the same process, thanks to the development of technics. Language, which had separated itself from the human through art and writing, is consummating the final divorce by entrusting the intimate functions of phonation and sight to wax, film, and magnetic tape.

II Memory and Rhythms

7 The Freeing of Memory

Species and Ethnic Group

Since the eighteenth century philosophers have been divided between two positions on the relationship between animal and human societies—one that sees the animal and human worlds as essentially identical, and one that accentuates the disparity between them. Both outlooks actually form part of the same movement, which goes back to the very origins of philosophy: the perception of an opposition between the material and the mental. This perception has been cast in many ideological molds over the centuries, and the opposition of nature to culture, of the zoological to the sociological, has reemerged again and again from the earliest metaphysical thinking down to contemporary sociology. If we study the view of the animal world held by Australian aborigines or Eastern Siberians, we find that fundamentally there is no essential difference between animal and human, that both have received the same intellectual gifts, and that their reactions, as reflected in myths over the ages, admit of parity and of a possible continuity of relations between them. The same view is apparent in the traditional European fairy tale, where animals speak and behave like humans.

The attitude recurs today in literary form, whether it be traditional tales, the stories of Kipling, or the adventures of Mickey Mouse. The fact that this type of writing is regarded as "children's literature" in no way diminishes its significance. Between this attitude and that of the nineteenth-century naturalist confronted with the social life of ants, the difference is minimal. Anthropocentism is at work in the search for the "language" of ants no less than in the many fairy tales in which a bear marries a human girl. And perhaps it is at work again in the efforts made to establish a radical separation between animal and human by opposing instinct to intelligence.

In mythological thought animal and human partake of the same essence, but their paths diverge at a certain point. The bear or the serpent are males, the bird-maiden is a female, when each has shed its outer skin of bear, serpent, or wild goose. Dressed in that outer skin, they adopt the species behavior that goes with it, exactly in the same way as people assume the behavior of their ethnic group or social class when they assume its clothing. This attitude, likewise anthropocentric, reveals a perception of the division of the living world into sociological units with distinct habits, customs, and external attributes, in contrast with the identity of living beings in their natural state. This view is so spontaneous and so universal that it cannot but reflect a real fact, that of the separation between our physical self and our external social shell. It extends to the animal world something that is specifically true of us, but it analyzes the essential fact that we belong to two worlds, the zoological and the sociological. It also brings out another essential fact, namely that we are humanly significant only through the behavior peculiar to our group, and if we bear in mind that in myths animals are identified with actual ethnic groups, it leads on to the recognition of the determining character of ethnic differences.

In the scientific thought of the past two centuries the same attitudes are to be seen on two levels—in the study of the respective functions of intelligence and instinct and in the search for the dividing line between the natural and the cultural. The first is concerned with animal psychology, the second with ethnology. Our earlier comments on the development of anthropoid societies by stages in which the link between the zoological and the sociological has become progressively more tenuous show that the problem can arise simultaneously at both levels, or rather that there is a possible third level that comes very close to our empirical picture of preliteral societies. Within the context of this third track, the problem of grouping would dominate the question of what is animal and what is human. Society of both animals and humans would be seen as maintained within a body of "traditions" whose basis is neither instinctive nor intellectual but, to varying degrees, zoological and sociological at one and the same time. To an outside observer the only thing that a society of ants and a human society have in common is the existence of traditions which ensure from one generation to the next the transmission of action sequences required for the social group's survival and development. We may argue over what is like and unlike in the two groups, but each survives thanks to the exercise of a real memory in which behaviors are stored. In animals this memory—peculiar to every species—is based on a highly complex instinctual apparatus, whereas in anthropoids the memory of each ethnic group rests on the no less complex apparatus of language.

To oppose instinct to language rather than to intelligence is legitimate only if there is true correspondence between the two terms so opposed, and that correspondence is what we shall try to demonstrate in this chapter. If it is true to say that the species is the characteristic form of animal grouping and the ethnic group of human grouping, then a particular form of memory must correspond to each body of traditions.

Instinct and Intelligence

Countless studies have been devoted to the apparently insoluble problem of intelligence and instinct. The debate, dominated by anthropocentric ideas until the early twentieth century, seems to have lost much of its vigor in the past generation. Neither instinct nor intelligence can be regarded as causes: They are effects. Instinct does not explain instinctive behavior; rather, philosophically speaking, it characterizes the accomplishment of ceratin complex processes of different origin. In the case of an individual, instinct may be said to be located at the intersection of the means specific to that individual and the external causes for deploying those means in action sequences. The external causes may be provided by education as well as by stimulation.

The distinction between instinct and intelligence is of practical interest only at the extremes of the scale—in insects as well as in humans—and even there its real value is difficult to measure. The action programs of the lower vertebrates are closely conditioned by their internal environment and by external stimuli. The active behavior of an amoeba or an annelid can be reduced to short sequences triggered or prolonged by causes unrelated to what might be termed "automatic intelligence" as opposed to "intelligence based on reflection." Therefore it is not possible to trace the supposed transformation of instinct into intelligence by starting at the bottom end of creation and proceeding to the higher animals. The only fact that emerges from experimental study of animal behavior is the plasticity of an individual animal's behavior in relation to its specific means. This must be interpreted as a liberation, not from instinct, but from the fixed sequences established at the confluence of the individual's internal biological environment and the exterior. The question is thus one of nervous apparatus rather than of the existence of a property peculiar to the animal condition. More precisely, the nervous system is not an instinct-producing machine but one that responds to internal and external demands by designing programs.

Today the concept of instinct appears too vague. We have become aware of the complexity of hereditary behavior patterns. But the existence of species-related memory[14] is difficult to challenge. It may manifest itself in action sequences resulting from the individual's gradual conditioning by external influences, to which it responds in the only ways for which it is hereditarily designed. The fact remains, however, that as one generation succeeds another the same sequences—or very similar ones—are reproduced from individual to individual. Instinct expressed as species-related memory is a reality only inasmuch as the resulting action sequences are constant in nature. Hence what is at issue is not the contrast between instinct and intelligence but only the opposition of two modes of programming, one of which—the insect mode—involves a maximum of genetic predetermination and the other—the human mode—apparently none at all. In fact the distinction is reflected in brain mechanisms which differ very widely between insects and humans, and the problem is less a matter of philosophy than of neurophysiology.

All living organisms can be divided into three groups in terms of instinct and intelligence. The first is that of the lower invertebrates with their very rudimentary brain system in which the programs take the form of short, stereotyped sequences of very simple actions reflecting the state of the balance between the organism and its environment. The memory of animals such as the earthworm, the slug, or the limpet can readily be compared to that of an electronic machine in the sense that (1) the animal is born with a determined range of needs and means of satisfying them, (2) its action sequences represent a struggle for balance between organic impulses and the external environment in a cycle where the action series is determined by physiological or external causes, and (3) the memory is incorporated in programs that determine the animal's conditioning. Nervous systems of this simple type have already been artificially reproduced, and the electronic apparatus employed in rocket control is already more complex than the brain of the lower molluscs or of annelids.

The second group is a good deal more problematic. It is represented by the bee or the ant, insects whose behavior appears to imply the presence of highly complex genetically recorded programs that go into operation at once and with disconcerting development in both the larva and the imago. The execution of these programs is today known to be less perfect than earlier authors had thought, but it would still be difficult to regard them simply as the interplay of external and internal environments causing the formation of a conditioned memory. In seeking to explain the insect's choice of plants or prey for its nourishment, its building practices, or its activities pertaining to social cohesion, we are obliged to adopt the concept of a nervous apparatus with highly determined responses to visual, olfactory, and tactile impressions. Such hereditary determination implies the existence of a potential memory whose operations appear preconceived because only a minimal choice of possible responses is available. We can, however, imagine an artificial apparatus that might select impressions created by light or by chemicals—or else by vibrations—and channel them into complex action sequences. We could even envisage a system that would allow a certain indeterminacy, a possible choice between impressions perceived as being equivalent. If every internal chemical state produced a specific reaction to impressions received from the outside, the economy of such a control mechanism would be very close to an insect's.

The third group would include vertebrates. Here the behavior of the lower invertebrates is reproduced in that the operating memory is largely conditioned by mechanical determinism, physiological impulses, and the demands of the external environment. Again, although ever less strongly as each branching achieves a higher degree of cerebral development, conditioning is connected with the existence of potential memory or, in other words, of automatic, "instinctual" behavior, which is the result of a genetic selection of possible responses. The vertebrate behaves as if following a preestablished program, an "instinct" whose consequences we may sometimes think absurd because it cannot adapt to situations not stored in the collective memory, whereas in fact it is producing a series of linked responses within the limits of its organic possibilities. Almost the entire behavior of the lower vertebrates (fish and reptiles) is of the first two types; we can imagine an electronic device that would, like the lizard, respond to phototropic or thermotropic stimuli, become more active with rising temperature, pursue any moving prey of swallowable size, reject any prey whose consistency or taste was recorded as being dangerous, and exhibit colored panels when visually or olfactorily excited. It should be added that actions performed for the first time by a process of trial and error would be recorded as programs in a series of memories whose interplay might subsequently trigger complex operating sequences, going so far as to cause a reversal of behavior during the performance of a sequence. What is conceivable in fish and reptiles is also, and to a much more complex degree, conceivable in birds, which demonstrate in profuse detail that the most elaborate part of automatic behavior is connected with reproductive activity. This is a general fact to which I shall revert in the chapter on "symbols of society" in connection with the relationship between aesthetics and the maintenance of group cohesion. In our present context we need only note that the elaborateness of automatic behavior varies considerably between, on the one hand, actions performed for individual survival and, on the other hand, those taken to ensure the survival of the species.

The behavior of the lower vertebrates may form part of the memory of higher vertebrates and may indeed constitute its main bulk. But as we rise higher in the series we observe a new element that suggests that the two earlier pictures may not be altogether complete. The characteristic feature of the individual behavior of mammals, at least so far as survival behavior is concerned, is the possibility of choice between action sequences, of checking the adequacy of each potential response to a given situation—a margin of control that varies from one species to another but is already very considerable in carnivores and primates. If we pursued the analogy with electronic devices, we should have to add to the apparatus for triggering responses and memories another mechanism capable of comparing and of orienting the device toward a particular response. Within the sweep of evolution, nervous systems in fact appear to have progressed in two opposite directions, some (those of insects and birds) toward behavior channeled more and more narrowly by the nervous apparatus and others (those of mammals and humans) toward a prodigious enrichment of the nerve pathways by connective elements capable of establishing connections between new situations and already experienced ones. The individual's memory, formed in the earliest period of life, then takes precedence over the species memory, which is merely the result of the hereditary arrangement of the nervous system.

Instinct and Freedom

One of the basic characteristics of humanity is the possession of a brain capable of making comparisons. Regulatory controls of elementary behavior are still present, however, in the lower stages of the human nervous system, and especially in the sympathetic system: The organism is subject to the same laws of balance between the external and the internal environment as that of the simplest invertebrates. The middle level, "instinct," is also present inasmuch as our operating behavior is molded by the genetic framework. Since sight and hearing are our predominant sense, our actions are genetically different from those of an animal whose chief references might be those of smell and touch. If instinct resides in the accomplishment of actions the implements for which are genetically conditioned, then a good deal of our activity is instinctual. In the short lineages that form within our constantly changing mass of humanity, genetically acquired intellectual or physical "gifts" represent the equivalent of the "instinctual" capital of animal lineages. The parallelism between the innate aptitudes of human individuals and those of animal species helps us to understand the nature of instinctual behavior. In neither case are we dealing with mysterious programs transmitted by atavism and developing automatically under favorable circumstances, but rather with hereditary neurovegetative mechanisms that permit the constitution of a memory recorded in action sequences. Among a thousand individuals given a musical education, only one may be genetically conditioned to become a great performer of whom it could be said that he or she played "by instinct"; but among a thousand musically gifted individuals only one perhaps will receive a musical education—the others will never have a chance to form their memory for musical execution, and the connection between their genetic aptitudes and the demands of the external environment will never be established. Vocational guidance in modern societies is only the empirical search for the genetic aptitudes that exist in humans as they do throughout the animal world.

Human operating behavior therefore draws upon a very extensive instinctual fund composed both of mechanisms for the regulation of deep organic impulses common to all individuals and of mechanisms capable of recording operating programs whose details may vary from one individual to another. This margin of individual variation, which is considerably wider than in even the most developed mammals, is an essential trait of human society. The "thinker," the inventor, the virtuoso, perform a crucial role in the dialogue between the physical entity and the collective organism that is society. We must realize that the presence of individual genius may be genetically normal in the human species and that progress is less a matter of personal genius than of a favorable collective environment.

That these facts are to some extent recognized is illustrated by the relative positions of spirituality and materialism in the ideologies of recent societies. In the great religions, and especially in Christianity, individual genetic aptitudes cannot cross the threshold of eternity, and hierarchy in those religions rests upon foundations that have nothing to do with such gifts. The saint is not necessarily a thinker nor an inventor or a virtuoso, but rather one who breaks out of the operating cycle and goes beyond and outside it. All great metaphysical philosophies are based upon this break which reflects our liberation from the genetic link and at the same time from the social one (at a different level, this reflects the homology of the species with the ethnic group). Materialist ideology—present not only in Marxist societies but, in pragmatic form, in all human societies—tends, on the contrary, to accentuate social efficiency. It emphasizes the importance of the genetic link by making a hero of the "gifted" individual. In capitalist societies the choice is made within the framework of a hierarchy divided into social classes, whereas Marxist societies tend to make use of genetic possibilities through the institution of "heroes of labor" and the cult of personality, a linear hierarchy founded upon the efficacy of individuals.

The human problem cannot, however, be understood with the help of instinctual factors alone. The all-too-often forgotten share of the zoological in human behavior must certainly be taken into account, but if we failed to integrate the mind in the general biological process we should be dealing with the infrastructure alone. In chapter 3 we saw the results of destroying the motor areas of the cerebral cortex change in a most revealing manner from the dog to the monkey and from the monkey to human. In the dog ablation of the motor cortex brings about an inability to remember operating sequences acquired by learning; in the monkey the zones of association bordering on the main motor area must also be eliminated, and in the human only the destruction of a very large area indeed will produce the same result. Earlier these facts provided us with the means of tracing the main stages of development toward reflective motor function. In our present context they indicate to some extent the degree of freeing of the human brain. The increasingly wide aureole that surrounds the centers of voluntary motor function corresponds to intelligence in the strict sense, that is, both to the capacity to store large numbers of operating sequences in the memory and to the capacity to choose between sequences. Between the most highly developed monkey and the human being, the difference in terms of freedom of choice is qualitative. True, the most intelligent anthropoid ape can never compare between more than a limited number of programs and its comparisons must rely on a considerably smaller neuronic apparatus than the human's, but the difference is essentially a matter of quality because reflexion is closely connected with language.

In our most common operations, language does not seem to intervene at all. We perform many actions in a twilight state of consciousness not basically different from that in which animals perform theirs. But as soon as the operating sequence is governed by choice it requires the intervention of a lucid consciousness closely connected with language. Freedom of behavior is attainable only at the level of symbols, not of actions, and symbolic representation of actions is indissociable from comparison between actions. From the lower animals to the higher mammals, the relative shares of conditioning acquired genetically and by learning are gradually reversed until a choice between simple operations becomes possible. But operating behavior remains completely rooted in lived experience, for projection can only take place once operations have been freed from their materiality and transformed into sequences of symbols. If we want to compare animal instinct with human intelligence, we must depart from the traditional meaning of each of those terms: We must view instinct as a set of phenomena so complex that the word no longer has a precise meaning, and intelligence as the ability to project symbolic sequences. This is tantamount to regarding language as the instrument of liberation from lived experience. In a parallel manner the hand-tool could be seen as the instrument of liberation from the genetic constraints by which an animal's organic implements are tied to the zoological species. At the level of language therefore, as at that of the implement, human intelligence observes the relationships we have already described.

Human technical behavior, with its consequences for the headlong development of the instrumental apparatus of society, needs to be considered at three levels: species-related, socioethnic, and individual. At the species-related level, human technical intelligence is connected with the degree of development of the nervous system and the genetic programing of individual aptitudes; certain proportions aside, nothing distinguishes it fundamentally from the behavior of animals, especially as regards its obedience to the extremely slow rate of species development in general. At the socioethnic level, human intelligence behaves in a wholly particular and unique manner in that, transcending both individual and species-related limits, it creates a collective organism with astonishingly rapid evolutive properties. For the individual the degree of socioethnic constraint is as imperative as the zoological constraint that causes one to be born *Homo sapiens,* but the terms of the former are different from those of the latter to the extent that, under certain conditions, they admit of the possibility of a certain degree of individual liberation.

At the individual level the human species is equally unique because, having received from the human cerebral apparatus the ability to compare between situations translated into symbols, the individual is capable of freeing him or herself symbolically from both genetic and socioethnic bonds. This enfranchisement forms the basis for the two complementary situations between which human reality is lived: one in which comparison between different operating sequences leads to material mastery over the organic world, and one in which enfranchisement from the organic world takes place through the creation of the intuitive situations in which human spirituality consists.

Social Memory

In primates hereditary operating behavior is increasingly influenced by an individually constituted memory; in humans the problem of operational memory is dominated by that of language. Although the role of genetic conditioning and conditioning through individual experience remains considerable, it is completely overlaid by education, through which human individuals receive the whole of their operating behavior. Individually constructed memory and the recording of personal behavior programs are entirely channeled through knowledge, whose preservation and transmission in all ethnic communities is ensured by language. This creates a genuine paradox: The individual's possibilities for comparison and liberation rest upon a potential memory whose entire contents belong to society. In insects memory is vested in society only to the extent that the latter represents the survival of a certain genetic combination in which the individual's possibilities of comparison are practically nil. But the human is both a zoological individual and the creator of social memory, a fact that may shed light upon the manner in which species-related and ethnic factors affect human behavior and that uniquely human two-way traffic between the innovative individual and the social community that makes for progress.

The most important consequences of the transfer of ethnic memory outside the zoological species are the individual's freedom to transcend the established ethnic framework and the ability of ethnic memory itself to progress. When we compare human societies with insect ones, we sometimes forget that in the latter genetically recorded behavior is dominant and imperative: Each individual must possess the entire capital of collective knowledge, and the society can evolve only at the rate of the paleontological drift. No really well-founded term of comparison between the two kinds of societies is conceivable because humans are free to create their own situations, even if these are only symbolic. Rapid and continuous evolution could apparently be achieved only by breaking the link between species and memory, an exclusively human solution. That being so, human societies can never become imprisoned in behavior comparable to that of insects. Their way and ours have been completely divergent all along. Paleontologists have often pointed out that our specialization consists in preserving the very general nature of our aptitudes. This applies far beyond the purely physical context. It is true that we run less quickly than the horse, cannot digest cellulose like the cow, climb less well than the squirrel, that our whole osteomuscular mechanism is superspecialized only in remaining capable of doing all of those things, but the most important fact is that the human brain has evolved in such a way that it remains capable of *thinking* everything—and that it is virtually empty at birth.

Individuals at birth are faced with a body of traditions that belong to their ethnic group; a dialogue takes place, from childhood, between the individual and the social organism. Tradition is as biologically indispensable to the human species as genetic conditioning is to insect societies: Ethnic survival relies on routine, the dialogue taking place produces a balance between routine and progress, routine symbolizing the capital required for the group's survival and progress the input of individual innovations toward a better survival.

The peculiar character of social memory emerges at another level as well. The creation of the first artificial tool by the first anthropoid put technics outside the scope of zoological realities and outside the multimillennial course of evolution, and at the same time made the social memory capable of adding to itself at a rapid rate. We have seen in earlier chapters that cerebral evolution before *Homo sapiens* remained incomplete and that technical evolution seemed to follow the very slow development of what humans still lacked in order to acquire an adequate apparatus for making comparisons. We have also seen that from the moment of the disappearance of the prefrontal ridge, a characteristically human evolution led to the birth of a technical world that drew upon resources outside the confines of genetic evolution. From the emergence of *Homo sapiens,* the constitution of an apparatus of social memory dominates all problems of human evolution; in chapter 9 we shall see by what means, up to and including the creation of an artificial brain, societies have attempted to record and preserve their uncontrollably growing capital of knowledge.

Once again, the dichotomy between the material and the moral becomes apparent. The theme of "man outstripped by his techniques" emphasizes the disparity between the evolution of technology and that of society's moral apparatus: In the course of thousands of years, we have acquired the technical means that have helped us to achieve an individually balanced mastery over the material environment, yet at the same time we continue in a disordered manner to employ a major part of those means in satisfying our predatory tendencies which hark back to times when humans were fighting the rhinoceros. This apparent inability to constitute a "lived" moral behavior on the level of our technical behavior has nothing abnormal or particularly distressing about it. It has, we hope, been demonstrated clearly enough that human evolution did not begin with the brain but with the feet, and that higher human qualities were able to emerge only in so far as the basis for their emergence had been constituted much earlier. For thousands of years individuals have had access to concepts of moral equilibrium quite as advanced as those achieved in technology. Societies have enshrined these concepts in their great moral and religious laws, but the genetic behavior of the mass of individuals who constitute society has not been freed from its fundamental constraints, which remain essentially predatory. Must we then conclude that tens of thousands of years must pass before a human brain more developed than that of *Homo sapiens* puts into effect the contents of moral memory? That is far from obvious; on the contrary, we believe that progress in this field, although strongly hampered by our incomplete liberation from biological constraints, nevertheless benefits from the means offered by technology for the collective arousal of our consciousness. The means of channeling and orienting our species-determined aggressivity may come from a clear perception of biological laws. Its total disappearance would probably mean the end of the human species, but conscious control of the link between thought and our physiological apparatus offers an optimistic prospect of the future.

Operational Memory

The forming of operational sequences raises, at its various stages, the problem of the relationship between the individual and society. Progress is achieved through the cumulative effects of innovations, yet group survival is conditioned by the recording of a collective capital presented to individuals in traditional life-sustaining programs. Operational sequences are formed as a result of interaction between experience, which conditions the individual by a process of trial and error identical to that of animals, and education in which language occupies a variable, though always decisive, place. We have seen earlier that human operational behavior comprises three stages. The first takes place at a deep level and is an automatic form of behavior directly connected with our biological nature. This stage provides the basis upon which education eventually imprints the data of tradition. Physical attitudes, eating habits, and sexual behavior rest upon this genetic base, their modalities being strongly marked by ethnic nuances. The second stage is that of mechanical behavior and includes operational sequences acquired through experience and education, recorded in both gestural behavior and language but taking place in a state of dimmed consciousness which, however, does not amount to automatism because any accidental interruption of the sequence will set off a process of comparison involving language symbols. This process leads on to the third stage, that of lucid behavior, in which language plays a preponderant role, either by helping to repair an accidental interruption of the sequence or by creating a new one.

These three stages succeed one another at each level of human behavior in varying proportions and in direct relationship with the survival of the social mechanism.

Mechanical Operational Sequences

Like any attempt to divide a continuum, the division of operational behavior into these three stages is arbitrary, but it coincides with the psychologists' categories of the unconscious, the subconscious, and the conscious, which in turn correspond to three levels of operation of the human neuropsychological apparatus. This distinction is certainly more important than one that might be drawn between instinct and intelligence in that it separates strictly instinctual, genetically channeled actions from sequences in which language and consciousness do not intervene in an ordered manner and do not express themselves through symbols. Psychological terms could no doubt be applied to technical operations, but they carry all kinds of implications that it would be best to avoid in the present context. In speaking of operational sequences, we therefore propose to use the terms "automatic," "mechanical," and "lucid" or "fully conscious."

Ethnology ignores automatic practices because it is more interested in what makes cultures different from one another than in what all humans have physiologically in common. Racial anthropology attaches some importance to identifying differences in the physical functioning of different races, and has even attempted to establish something like a racial psychology. But practically nothing is known about what is genetically significant; most of the differences observed belong to the cultural superstructure. Literature on the subject of "wolf children," strongly tinged as it is with legend, yields hardly any scientific information as to what a human being living exclusively off the genetic fund might be like. Although the role of our anatomical and physiological heritage is undoubtedly decisive, we must finally conclude that spontaneous behavior in the human species is overlaid by behavior acquired through the social community. Within the perspective adopted in this book, however, we must not fail to attach due importance to spontaneous behavior. The problem will be taken up again later in the context of gesture and of aesthetic categories.

Although data on the automatic aspects of operational behavior are scarce, practices whose roots are to be found in collective life offer opportunities of observing the influences exercised reciprocally by the individual and the environment. Every action performed by an individual forms part of his or her operational behavior, but it does so in different forms and with different degrees of intensity depending on whether the practice is elementary and recurrent on a daily basis, occasional or exceptional. The programs involved presuppose different levels of intellectual activity and different relationships between the individual and society. Elementary practices are the individual's vital programs. They include all those daily actions that affect one's survival as an element of society: bodily constitution, dietary and hygienic habits, actions performed in the exercise of one's profession, actions involved in one's association with family and friends, and so forth. These programs, drawn from an unchanging fund, are organized in sequences of stereotyped gestures whose repetition ensures the individual's normal balance within the social environment and his or her own psychological comfort within the group. Elementary operational sequences are acquired early in life through training by imitation, experience by trial and error, and verbal communication. The individual's integration in society depends upon the smooth performance of these operational sequences in normal life. Most of the sequences we perform between waking and going to bed require only slight conscious intervention; they take place, not in a state of automatism where consciousness would be nil, but in a psychological twilight from which the individual is aroused only by some unforeseen occurrence. In the gestures we perform when washing and dressing or eating our meals or writing, the return to full consciousness is exceptional but it is decisive, and that is why I prefer to speak of "mechanical operational sequences" rather than of automatic, unconscious, or instinctive ones.

Mechanical operational sequences form the basis of individual behavior; they are our essential element of survival. Under the conditions of human life they take the place of "instinct" because they imply a high level of potential cerebral activity or "cerebral availability." Operational behavior requiring constant full consciousness is actually unimaginable, just as is completely conditioned operational behavior in which full consciousness can be dispensed with altogether—the former because every gesture, including the least significant, would have to be reinvented, the latter because it would presuppose a completely preconditioned, and therefore inhuman, brain. The human brain is so designed that it can reserve a part of its availability by creating elementary programs that guarantee freedom of behavior under exceptional circumstances. These elementary practices, whose sequences begin at birth, place the strongest ethnic imprint upon the individual. The gestures, attitudes, and ways of behaving in humdrum day-to-day situations form that part of our link with the original social group from which we never free ourselves even when transplanted into a different class or ethnic environment.

Today's political readjustments and the general process of "planetarization" currently taking place are causing serious problems in this respect. For the individual, the diversification of ethnic groups and the emergence of operational practices common to fairly large social units are a matter of psychological balance. In our particular zoological group the ethnic unit replaces the species: human individuals differ ethnically as animals do in terms of their species. At the level of elementary practices, this specificity is perceived only by contrast: Certain gestures that I perform are felt to be peculiar to my group only by contrast with those of strangers. Ethnic practices are thus a source of differentiation, though, by the same token, also of comfort and intimacy among members of the same group, and they make individuals isolated in a strange environment feel even more uprooted. Completely interchangeable individuals would no doubt benefit society, in its role of consumer of individuals in the name of social progress, but to what extent would society still encompass members if they ceased to be ethnically diverse? Whatever the answer to that question may be (we shall revert to it later), mechanical operational sequences form the fund of individual behavior common to members of the same ethnic group. They are performed at a deep level of collective memory and involve language only to a limited extent. Not until a very advanced stage of organization of collective consciousness do we find the social or professional gesture written down in books on etiquette, "how-to" books, or textbooks on ethnography. The transmission of elementary sequences is essentially connected with the organization of social cells of limited size and, in particular, of families or groups of children or adolescents. Games involving imitation of adults play an important role in this process.[15]

Thus active individuals orient the major part of their activities with the help of programs established in the course of their ethnic group's development and recorded in their motor memory by education. They perform these action sequences or "chains" in a state in which full consciousness intervenes in order, as it were, to adjust the links of the chain. To put it more precisely, lucidity follows a sinusoidal curve whose troughs are mechanical series and peaks represent adjustments of those series to the operation's specific circumstances. This is already a characteristic of the intelligence of higher mammals. In us it is so intense as to be one of the decisive characteristics of human behavior. Conscious intervention, connected as it is with the ability to compare, not only orients the operational process but also enables us to cope with accidental situations—that is, to rectify the operational process by adjusting the appropriate links of the chain. The possibility of rectifying, of making improvements both in the field of social relations and in that of technology, is the invention factor: It reasserts the role of the human individual as inventor in the general course of progress. The characteristic capacity of human societies to accumulate and preserve technical innovations is connected with the collective memory. Our role is to organize our operational sequences consciously toward the creation of new processes.

Periodically Recurring or Exceptional Operational Sequences

In the case of operations that go beyond mechanical sequences—seasonally recurring agricultural activities, giving a feast, building a house, group fishing or hunting—the collective memory is organized differently. The role of the mechanism that records the operational series in the collective memory varies in importance depending on the length of the interval at which the operation is performed. In each case language intervenes as the medium for the actions to be performed. All societies without writing possess a range of means of preservation in the form of proverbs, precepts, or recipes, often stored in the memory of only a few individuals. Periodic operations, especially long-term ones, require more than mechanical storage and represent one of the traits that most radically distinguish human society from the rest of the zoological world. In animal societies there are operations that occur seasonally or only once in the lives of individuals, triggered by the succession of seasons or by physiological maturing. The animal will then perform new sequences within the channel of its genetic preconditioning, or it will pick up the thread of operations already experienced under identical conditions. Much of the human attitude toward periodic operations is also connected with the seasonal cycle and with physiological maturing: The same collective operation is lived differently depending on the individual's age and experience, but the process is traditional rather than genetic and is maintained in a set of verbal formulations that forms part of the ethnic capital.

Operational Behavior as a Whole

Human operational behavior, although apparently forming a single whole, thus involves several highly complex processes. It is of course closely connected with social life, but it cannot be circumscribed either by crudely contrasting human intelligence with the bee's instinct or by concluding that because both insects and human beings live in society, their societies are essentially the same.

The human in fact is both closer to the animal world than the traditional dichotomy between instinct and intelligence would have us think and much further from it than might be inferred from the striking similarities between the social structures of all animals with an organized collective life. We seem to have lost nothing of what may have been our remote kinship with the trilobite or the earthworm. Every element of psychological organization that the vertebrate needs for its vital balance we need too. But all these elements are the steering wheel that steers our vegetative activity behind what is particular and peculiar to ourselves alone: our symbolizing faculty, or to put it more generally, that property of the human brain that consists in maintaining a distance between lived experience and the organism that serves as its medium. The problem of the dialogue between the individual and society, which has come up in connection with the question of intelligence and instinct and which will come up again and again in the rest of this book, is nothing other than this capacity human beings have of distancing themselves from their environment, both external and internal. This detachment, which expresses itself in the separation between tool and hand and between word and object, is also reflected in the distance society creates between itself and the zoological group. The whole of our evolution has been oriented toward placing outside ourselves what in the rest of the animal world is achieved *inside* by species adaptation. The most striking material fact is certainly the "freeing" of tools, but the fundamental fact is really the freeing of the word and our unique ability to transfer our memory to a social organism outside ourselves.

This twofold distancing—of tools and of the memory—will form the subject of the next chapters.

8 Gesture and Program

A study of technics limited to classifying different types of tools and analyzing different stages of manufacturing processes would bear the same relation to ethnology as systematic zoology does to animal biology. In such a study tools exist only as part of the operating cycle. They provide evidence of the cycle because they generally carry significant traces of it, but no more so than a skeleton of a horse does of the swift herbivore to which it once belonged. Systematic technology, which forms the subject of the two volumes of my *Évolution et techniques,* is an indispensable basis, yet the real significance of tools is in the gesture, which makes them technically effective.

The concept "tool" itself needs to be reviewed with reference to the animal world, for technical action is found in invertebrates as much as in human beings and should not be limited exclusively to the artifacts that are our privilege. In animals, tool and gesture merge into a single organ with the motor part and the active part forming an undivided whole. The crab's claws and jaws are all of a piece with the operating program through which the animal's food acquisition behavior is expressed. The fact that human tools are movable and that their characteristics are not species related but ethnic is basically unimportant. The sociocultural divisions that make a particular technical operation typically New Caledonian in terms of both the method and the tools employed have simply taken the place of the psychozoological divisions that make certain operations and a certain physical apparatus typical of particular species of animals.

The operational synergy of tool and gesture presupposes the existence of a memory in which the behavior program is stored. With animals, this memory forms part of organic behavior as a whole, and the technical operation becomes, in the popular sense, "instinctive." We saw earlier that in humans, the mobility of tools and language has determined the exteriorization of operational programs related to the survival of the group. What we must now do is to trace the stages that have led to a liberation so great in present-day societies that both tool and gesture are now embodied in the machine, operational memory in automatic devices, and programing itself in electronic equipment. Most of what needs to be said about tools is already to be found in earlier chapters. Gesture, however, has not often been considered by a method in which animal behavior and the deliberate motor activities of humans are viewed from the same perspective.

Elementary Analysis of the Gesture

The osteomuscular apparatus of primates is similar enough to the human's for its mechanical properties to be considered largely equivalent to ours. Human movements are no doubt more finely differentiated than those of monkeys, but the anatomical differences are negligible compared with those of the neuromotor apparatus. Ordinary monkeys, anthropoid apes, and the human can therefore be considered to have the same anatomical and gestural possibilities.

The essential traits of human technical gesticulation are undoubtedly connected with grasping. We saw earlier that grasping actions are characteristic of a whole category of mammals starting with rodents and carnivores, which show varying degrees of the same aptitudes. The distinction between operations in which hand actions are combined with actions of the face, particularly of the lips and the front teeth, and operations in which hand actions, bilateral or unilateral, are performed without facial participation is evident at different levels. We became aware of the importance of this distinction when we analyzed the formation of the anterior field. To it we must add another that is particularly important when analyzing the technical behavior of humans—the mode of action peculiar to the hand. Action peculiar to the hand consists in the potentially wounding effect of fingernails, in grasping operations involving the fingers and the palm (digitopalmar prehension), and in grasping between the fingers (interdigital prehension). Since movements of transmission or rotation determine both our manner of holding a hand tool and the impetus we apply to it, a fourth term descriptive of the leverage exercised by the forearm and the arm is needed in order to analyze human gestural behavior in the technical field. A full analysis would have to be based on the whole of the body, but here we need go no further than to suggest a method of ordering the main categories of the gestural behavior of the higher mammals and the human.

The interest in defining the common capital of monkeys and the human being does not lie in finding human elements in the monkey but in analyzing the elements of physiological anatomy common to both. Figure 106 shows the technical behavior of primates and human technical capital from the earliest beginnings until the dawn of *Homo sapiens*.

The elementary behavior of monkeys and anthropoid apes involves coordinated or isolated action of the forelimb and the face against the moving background of the body mass in operations relating to the acquisition and consumption of food, to aggression or defense, and to associative behavior through facial or manual contact. Unlike the rodents, which almost exclusively seize or palpate by grasping with the lips and teeth, primates use the hand by preference.[16] This reversal of the proportion between the respective uses of the hand and the face in a number of actions not basically different from those performed by rodents having a prehensile hand is in itself sufficient to set the primates apart from the rest of the mammals. It marks the beginning of human operational behavior processes.

From primate to human being, grasping operations do not change in nature but develop in terms of the variety of ends pursued and the delicacy of execution (figure 106). Digitopalmar grasping operations, affectionate or hostile contact, kneading or using the hand as a receptacle remain fundamental in bare-handed techniques, while the interdigital operations performed by primates for the purpose of grooming or peeling assume considerable importance in techniques requiring some delicacy of execution, such as spinning yarn. The fact that our brain as it is today was the human being's most recent acquisition emerges more clearly from the study of technical gestures than from any other form of research because the result of a technical gesture does not require any part of the osteomuscular apparatus that is not already present in the higher monkey: The difference is one of nervous apparatus alone.

The borderline between the primate and the first toolmaker is not a matter of technical possibilities: The great apes can grasp, touch, pick, knead, peel, and handle; they tear food apart using fingers and teeth, crush with their molars, cut with their incisors, hammer with their fists, scratch and dig with their nails. The list of what primates can do includes every one of the operations attested by Archanthropian or Palaeoanthropian tools.

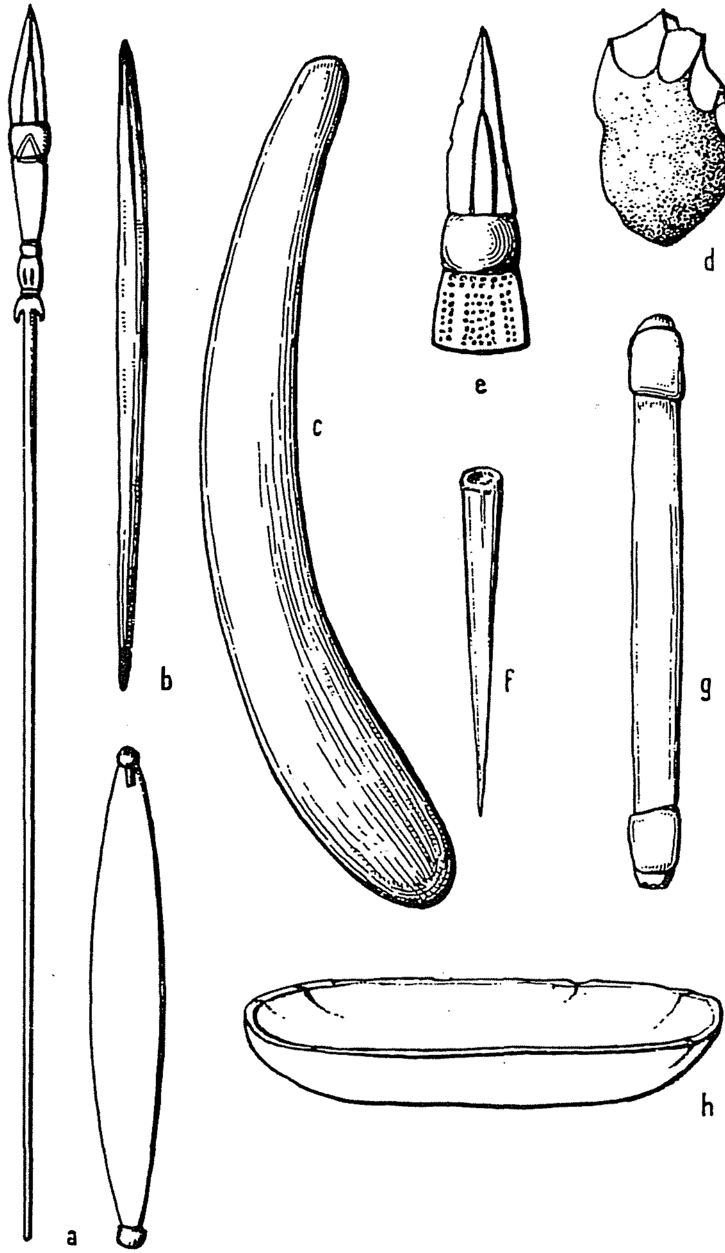
In an earlier chapter we arrived at the impression that tools were "exuded" by humans in the course of their evolution. A moment came when the lineage was mature enough to produce the free-handed biped to whom the first part of this book is devoted, a biped who emerged without losing touch with the continuum of living organisms, totally different—even in his most elementary humanity—from the most advanced of the monkeys but carried along on the same tide. An identical impression

		Dental percussion	Manual percussion	Percussion with the nails
	Aggression Acquisition Feeding	Crushing Sectioning	Hammering	Scraping Digging
Grasping: labio-dental	Relationship	——	Tearing ——	
Digito-palmar	Brachiation, seizing Affective contact Kneading Cupping Snuggling, protection	Crusher Knife Awl Spike	Chopper, hammer, club Spatula	Notcher Digging-stick, pick, hoe
Interdigital	Peeling Grooming Molding	Graver Punch Needle		Scraper
Projection		Spear	Stone, projectile Bola	

106. Elementary connections between actions and primitive tools.

arises even more powerfully when we analyze technical gestures and see how our tools sprang, literally, from the nails and teeth of primates without the smallest perceptible interruption.

The technical equipment of the earliest anthropoids—the Australanthropes and Archanthropes—consisted of percussion tools, rough-edged choppers, stag antlers cut down to make clubs or digging sticks, and spherical projectiles for which the act of throwing was a direct development of earlier gestures. The human hand is human because of what it makes, not of what it is, namely a fairly simple osteomuscular device capable, from the monkey, of performing, in a mechanically very economical manner, movements of grasping, rotation, and transmission which thereafter undergo no change. The human value of the gesture is not in the hand—for which freedom while walking is a sufficient precondition—but precisely in the



107. Equipment used by Australian aborigines: (a) spear and throw-stick, (b) digging stick, (c) boomerang, (d) chopper, (e) knife, (f) piercing tool, (g) double scraper, (h) dish made of bark.

ability to walk upright and its paleontological consequences for the development of the cerebral apparatus. The gradual enrichment of tactile sensibility and of the neuromotor apparatus occurred qualitatively without changing the nature of the basic equipment.

The complex actions of grasping, handling, and kneading which already existed at the primitive anthropoid stage still account for a large share of our technical gestures today. But with the emergence of the percussion tool, the chopper and the antler employed for a practical purpose, a perceptible shift took place. Cutting, crushing, molding, scraping, and digging operations were transferred to tools. The hand ceased to be a tool and became a driving force.

The Intermeshing of Tools and the Motive Gesture

The hand's modes of action became gradually enriched during the operational process in the course of human evolution. The *manipulative action* of the primates, in which gesture and tool form a single whole, was followed in the first anthropoids by *directly motive action of the hand* with the hand tool separable from the motive gesture. In the next stage, reached possibly before the Neolithic, gesture became annexed by the hand-operated machine, the hand merely supplying its motor impulse by *indirect mobility*. In historic times motive force itself was transferred from the human arm, and *the hand intervened only to start the motor process* in animal-operated machines or mechanical machines such as mills. Finally, in the last stage, *the hand is used to set off a programmed process* in automatic machines that not only exteriorize tools, gestures, and mobility but whose effect also spills over into memory and mechanical behavior.

This enmeshing of tools and gestures in organs extraneous to the human has all the characteristics of biological evolution because, like cerebral evolution, it develops in time through the addition of elements that improve the operational process without eliminating one another. Earlier we saw that the brain of *Homo sapiens* still preserves all stages acquired since the fish stage, and that each stage, overlaid by the next, continues to play a role even in the most sophisticated forms of human thought. Similarly the existence and operation of an automatic machine with a complex program implies that at every stage of its manufacture, regulation, and repair, all categories of technical gestures—from handling metals through handling a file to coiling electric wire to assembling the machine's parts, whether by hand or mechanically—are still present though only faintly discernible.

Handling

The complex operations of grasping, rotation, and transmission that characterize handling were the first to appear and have crossed the ages without undergoing any transposition. They still form our most common stock of gestures, the prerogative of the human hand which is so very archaic and relatively so unspecialized by comparison with those marvelous machines for capturing or running that are the "hand" of the lion or the horse. The privilege of long life which in paleontology is enjoyed by species that are not overspecialized also attaches to operations performed by the bare hand with which, to this day, the finest forms of architectural construction, pottery, basketry, and weaving are connected.

Devices for grasping, transporting, and positioning objects did not become available in assembly lines or in the form of automatic manipulators until a highly advanced stage of industrialization had been reached. In cranes and pulley blocks, known since ancient times, the hand intervenes only as a hook and the machine is a simple exteriorization of the motive force. The example of weaving too is conclusive: In the most elaborate fabrics such as those of Peru or in oriental brocades, the hand picks up the threads individually in order to make the desired design. Yet freeing of the fingers was achieved quite early, perhaps as early as the Neolithic, by reducing operations to the repeated lifting of one thread in two or three. Not until the nineteenth century did the introduction of a punched-card system raise mechanical weaving to the level of handling skill of which the bare hand had been capable from the start. In both cases the development is the same: In the first stage, the hand can perform actions that are limited in terms of force or speed but infinitely diverse; at a later stage, that of the pulley block or the weaving loom, a single action of the hand is isolated and transferred to the machine; in the third stage, the programming of movements is reconstituted through the creation of an artificial and rudimentary nervous system.

The Hand Acting through Direct Motor Function

Unlike handling, actions involving the use of the teeth or nails became exteriorized from the very first. In these actions the hand merely serves as a pincer at the extremity of a device that has a direct motor function and is suitable for percussion of various kinds (see my *L'Homme et la nature*).

The range of percussive actions of which Anthropoid apes are capable is quite wide, but their main instrument is the teeth—incisors for cutting and scraping, canines for piercing and tearing, molars for crushing. The role of the hand consists above all in presenting the object to the teeth or in preparing it for being eaten. The nails are employed only in operations involving scratching or digging, but their action is important because of its rhythmic nature. If we consider the operational behavior of the great apes, we are left with an impression of a potential rudimentary technicity based on dental percussion, handling, and recurrent scraping movements. Everything required to constitute human technicity is already there, and it all comes together the moment tools enter upon the scene.

Lacking records as we do, we find it difficult to visualize how the incisor became a chopper—how, in other words, our only organic tool capable of cutting, worn on the projecting end of the jaw, became transferred to the hand via the incisive action of a splintered pebble. We do know, however, that at an extremely early stage, by the time of the Australanthropians, this transfer seems to have been effected. Here again, walking upright played the decisive role. In monkeys the two operating fields (biting and handling) are involved simultaneously when the quadruped is seated and separately when it is walking; the dental apparatus remains the forward point of the body and the animal's chief organ of association. With erect posture, the hand takes over as the organ of association. Operations performed when seated remain connected with simultaneous action of the face and hand (food consumption and technical operations involving the teeth), but labiodental contact is no longer dominant as in quadrupeds, nor even equivalent as in many monkeys. In the human it continues to be important only in affective contact and in a few technical operations where the mouth serves as an additional claw or pincer. The transition to tools is thus functionally justified by the transfer of the field of association to the hand.

To view the chopper as an incisor placed at the ends of our fingers or the percussion tool as a molar brandished in the fist would be childishly fanciful: Yet it is true that the scale of actions remained the same before and after the transfer that took place at the hypothetical point in time when an upright-walking primate transposed its percussive activity from the teeth to a pebble activated by the arm. The vast number of objects with which humans have surrounded themselves obscures the fundamental simplicity of the tools they need for survival. The forms of the technical equipment used by Australian aborigines are few in number: the spear and the throwing-stick for hunting, the digging stick for gathering, the pebble crusher, the knife, the flint chopper and scraper for the preparation and consumption of food, the bone awl, fibers for tying, pieces of bark to serve as receptacles. What we know of fossil humans up to and including the Palaeoanthropians is of the same order and covers a range of dental and manual actions exactly the same as that of the primates: The percussion tool attests to crushing and hammering, the deer antler used as a digging tool, and the small scraper used on wood to scraping; cutting actions, whether by direct application of a hand-held tool or by throwing a sharpened weapon, are performed with sharp-edged splinters and the chopper or biface. In the Upper Paleolithic, with *Homo sapiens,* the range widens, but there is nothing to indicate—except in levers and traps—that indirect motor function had been achieved.

The ability of the hand to exercise indirect motor function reflects another "liberation," with the motor gesture finding new freedom in the *hand-operated machine* that extends or transforms it. The point in time when this important stage was reached is very difficult to define. It does seem, however, that by the late Paleolithic there were at least two implements attesting to indirect motor function, the pierced stick and the spear thrower. The former is a length of reindeer horn pierced with a hole and probably employed as a lever for hot-straightening bone rods. With this tool both the force and the direction of movement of the hand are transformed. This very simple application of indirect motor function in the form of a tool that acts upon the direction of movement is found as early as in the Aurignacian period, some 30,000 B.C. Evidence of the hurling stick dates back to a later period, the Magdalenian, around 13,000 B.C. This is a hooked stick that serves to accelerate spear-throwing (see my *Milieu et techniques*) by adding the mechanical value of an extra elbow and forearm to the arm of the thrower, who holds it in his hand.

From that point onward and until the dawn of historical time, applications of indirect motor function developed further. The transition to an agricultural-pastoral economy caused them to become incorporated in a variety of techniques and in many forms—as springs and levers, as continuous or alternating motion in hand-operated machines such as the bow or the crossbow, in snares, pulleys, millstones, cranes, and transmission cables. These machines, which are discussed in my two earlier books, reflect a logical stage in human evolution. As with hand tools the process whereby all implements came gradually to be concentrated outside the human body is again perfectly clear: Actions of the teeth shift to the hand, which handles the portable tool; then the tool shifts still further away, and a part of the gesture is transferred from the arm to the hand-operated machine.

The Hand Separated from Motor Function

The evolution continued with muscular impetus itself becoming separated from the human body through the harnessing of the motor function of animals and of wind and water. It is a singular property of the human species that by confining itself to engendering action, it periodically eludes the organic specialization that would definitively tie it down. If the hand of the earliest anthropoid had become a tool by adaptation, the result would have been a group of mammals particularly well equipped to perform a restricted series of actions: It would not have been the human being. Our significant genetic trait is precisely physical (and mental) *non*adaptation: a tortoise when we retire beneath a roof, a crab when we hold out a pair of pliers, a horse when we bestride a mount. We are again and again available for new forms of action, our memory transferred to books, our strength multiplied in the ox, our fist improved in the hammer.

The freeing of motor function is the decisive stage, perhaps not for the individual but for human society collectively in possession of each member's means of action. The phenomenon is a very recent one. The adoption of animal traction and of machines activated by water or wind are reported in ancient history; moreover it was confined to a few Eurasian civilizations whose technoeconomic supremacy continued to be founded upon it until the eighteenth century. Generally regarded as historical phenomena of technical significance, the invention of the four-wheeled carriage, the plough, the windmill, the sailing ship, must also be viewed as biological ones—as mutations of that external organism which, in the human, substitutes itself for the physiological body.

The *animal machine* requires a good deal of muscular participation. Motor function is "deflected" to drive the animal motor, but it remains considerable. Moreover the efficiency of the animal-driven machine became stabilized very early on and at a rather low level: The number of horses does not increase the speed of the vehicle nor, within certain limits, their resistance to fatigue.

The relationship between humans and their exteriorized force is altogether different in the *automotive machine,* including even the simplest water-driven pile-driver or mill. Having set the process in motion, the hand no longer intervenes except to feed or to stop the machine. The operator can increase the machine's power or distribute it among machine tools which will perform all the operations for which human intelligence has designed them.

The conquest of water and wind was accomplished in antiquity—early in historic time—but for many centuries they remained the only sources of automotive power. Not until the nineteenth century was the decisive step taken with the harnessing of steam pressure.

The momentous nature of the change in scale of the relations between the human and the natural world was clearly perceived at once. The initial conquest of metals had been a triumph of the hand: the conquest of steam definitively confirmed the exteriorization of muscle power.

However, human participation was still considerable, and the Age of Steam was also the age of the cruelest enslavement of the manual worker. The automotive machine of the nineteenth century possessed neither a brain nor a hand. Its nervous system was extremely rudimentary, consisting simply of speed and pressure regulators discharging a constant but blind force. The worker operating the machine provided the brain that made that force useful and the hand that stoked the fire, fed raw material to the machine, and oriented and rectified its action.

Nevertheless, if we are agreed that biological change affects both the physical organization and the behavior of the organisms concerned, the birth of automotive force was a crucial biological stage. The fact that the organs involved are extraneous to the body matters little if the change creates a new living reality. We have seen that human evolution from *Homo sapiens* onward has been a story of more and more radical separation between the rate of change affecting the body—still governed by the geological time scale—and that of change affecting tools, which now occurs with every generation. If the species was to survive, some accommodation was necessary, and this accommodation was bound not only to affect our technical habits but also to involve thoroughgoing changes in the laws according to which individuals group themselves together. Of course the parallel with the zoological world cannot be maintained except by way of paradox, but we cannot completely dismiss the thought that some species change takes place whenever humankind replaces both its tools and its institutions. Although peculiar to humans, the changes that affect the entire structure of our collective organism hang together in much the same way as changes that affect all the individuals in a group of animals. From the moment when the exteriorization of motive force became unlimited, social relations assumed a new character; a nonhuman observer unfamiliar with the explanations to which philosophy and history have accustomed us would separate the eighteenth-century human from the human of the tenth century as we separate the lion from the tiger or the wolf from the dog.

The Automatic Machine Nineteenth-century machinery was still a long way from the ideal mutation whereby exterior to the human there would be another, wholly artificial human acting with unlimited rapidity, precision, and force: a long way from the moment when everything—tool, gesture, strength, and thought—would be transposed to a perfect twin image of the social ideal. The gradual establishment of a social organism wherein the individual increasingly plays the role of a specialized cell makes it more and more clear how inadequate the human being is—the flesh-and-bone human, a living fossil, immutable on the historical scale, perfectly adapted to external conditions at the time the human species was triumphing over the mammoth but already overtaken by them when required to use muscle to operate the trireme. Our constant search for more powerful and more precise implements has inevitably led to the biological paradox of the robot, a creature which, in the form of the automaton, has haunted the human mind for centuries. The ape-ancestor image evoked in chapter 1, the expression of a nostalgic retreat into the past, has its counterpart, not in the spiritual image of the angel or the physical one of a perfect human body, but in the image of the perfectly made machine, the Anthropoid's mechanical twin—Tarzan, the astronaut, and the robot gravitating like a constellation around the human of flesh and blood.

Many of the mechanical monsters produced in the nineteenth century still survive today—machines without a nervous system of their own, constantly requiring the assistance of a human partner. Developments in the use of electricity, and above all the rise of electronics, taking place less than a century after the mutation that produced automotive machines, have triggered another mutation that leaves but little in the human organism still to be exteriorized. Machines have changed radically as a result of the development of small-scale motors, photosensitive cells, transistors, and miniaturized devices of all kinds. This disparate arsenal is supplying the parts for a composite body strangely similar to the biological one. Whereas nineteenth-century machines with their voluminous energy sources conducted a single force to blindly acting organs via extensive transmission systems, today's machinery with its multiple sources of energy is leading to something like a real muscular system, controlled by a real nervous system, performing complex operating programs through its connections with something like a real sensory-motor brain.

Mechanical automation, from the mechanical brontosaurus of the nineteenth-century rolling mill to the automatic pilot of today, represent the penultimate possible stage of the process begun by the Australanthrope armed with a chopper. The freeing of the areas of the motor cortex of the brain, definitively accomplished with erect posture, will be complete when we succeed in exteriorizing the human motor brain. Beyond that, hardly anything more can be imagined other than the exteriorization of intellectual thought through the development of machines capable not only of exercising judgment (that stage is already here) but also of injecting affectivity into their judgment, taking sides, waxing enthusiastic, or being plunged into despair at the immensity of their task. Once *Homo sapiens* had equipped such machines with the mechanical ability to reproduce themselves, there would be nothing left for the human to do but withdraw into the paleontological twilight. In point of fact, the chance of machines equipped with a brain taking our place on earth is slight; the threat lies within the zoological species itself, not directly in the exteriorized organs. The nightmare picture of robots pursuing human beings in a forest of mechanical tubes will come true only to the extent that other human beings will have regulated the robots' automatic system. What is to be feared—if only slightly—is that in a thousand years' time *Homo sapiens,* having exhausted the possibilities of self-exteriorization, will come to feel encumbered by the archaic osteomuscular apparatus inherited from the Paleolithic.

Mechanical Program and Mechanical Memory

The development of automatic programs represents a peak in human history, comparable in importance with the emergence of the chopper or the rise of agriculture. Because it has occurred so recently, it can provide us with some insight into the mechanism of great technical mutations in general. The idea that a series of technical gestures might be performed mechanically evolved very slowly in historical time. Automatic machines capable of performing a single gesture, like the water-driven pile driver, were developed in Mediterranean or Chinese antiquity, but the idea of mechanical programing was technically unrealizable until the Middle Ages. The first means of programing by purely mechanical processes were found in clockmaking. A technical confraternity specialized in giving material expression to the concept of time provided a favorable environment for innovation. The medieval clockmaker, a specialist in progression and animation, learned to use pinions and cams and to combine circular with rectilinear motion in order to devise the simple program of the first animated clocks and automata.

The evolution of animation depended on that of the source of motive power employed. From the twelfth to the fifteenth centuries, clockwork mechanisms were operated by rectilinear traction using a weight, a system that considerably restricted their possibilities. From the fifteenth century on, the use of a spiral spring provided a means of reducing the size of the automatic device and making it portable. Improvements to the mechanism led to the eighteenth-century automata, which represent the peak of what could be achieved in programming with clockmaking devices. The nineteenth century saw a change in the scale of the pinions and cams employed and the invention of steam-operated machines capable of simple gestures. Like the automata that preceded them, these machines represent a fascinating stage of technical evolution not without parallels in animal evolution.

Mechanical automata are programmed to perform a sequence of simple gestures in an order prescribed within the mechanical organs themselves. The operating memory is situated at the level of the cams, a little to the back of the machine's active part; there is no nervous system and no coordination network other than the transmission mechanism. Jacques de Vaucansson's automata are to electronic devices what the earthworm is to the mammal. In other words, they are like living organisms with a segmental memory stored in each of their active elements, cams being distributed to each part to be animated like the chain ganglions that animate each of the annelid's joints.

By a completely different path, automatism entered weaving techniques at the beginning of the nineteenth century. Joseph Jacquard invented a loom for patterned fabrics using a set of punched cards which determine what threads should be picked for each run. A complex pattern can thus be executed by wholly automatic means. Barrel organs using perforated bands of paper, which operate on a similar principle, made their appearance at about the same time. The Jacquard loom and the barrel organ can be described as a pair of automatic machines which, in terms of their principle, are opposable to the pair formed by the automaton and the music box. Perforated card machines are equipped with a centralized memory separate from the executing organs, to which it transmits a real message corresponding to a program capable of a large number of modifications. Like the tune of the music box or the bird organ, the program that actuates an automaton's finger comprises a set of cogwheels. It is invariable for a specific mechanical situation and can be modified only by adopting a different mechanical formula, just as the progression of the annelid consists in coordinating the simple movements of a series of joints endowed with an invariable motor function. The program of the Jacquard loom is external to the organs of execution—it is "intelligent" by comparison with a mechanical device. Furthermore, by changing the set of perforated cards the machine can be made, without any mechanical modification, to perform a different set of operations. A "nervous system" proper is not yet there, but everything that the nineteenth-century technical environment could contribute toward developing a memory machine is already in place.

Not until the last twenty years* has the mimicry of living matter by artificial matter achieved a reasonably high standard. A century of familiarization with electricity and, later, with electronics was needed before this became possible. The resulting

*Translator's note: Again, it may be useful to remind the reader that this book was first published in 1964.

machine represents a synthesis of all previous stages. Mechanical organs of execution, actuated by as many energy sources as efficient articulation may require, are set in motion by a program that, at one stage at least, is recorded on tape. The essential difference lies in the presence of what amounts to a real nervous system through which the central organs transmit commands and monitor their execution. The sequence of mechanical gestures is prescribed by a transformable memory. The physical health of the machine is checked by organs that regulate the speed, temperature, and humidity of each organ. The texture and form of the substance being processed is examined by ponderal, tactile, thermosensitive, or photosensitive organs that transmit their findings to automatic regulating centers, and the machine can orient, correct, or suspend its actions in response to messages it receives from its "sensory" organs. A biologist will find it hard to resist comparing the mechanisms of animals whose evolution is already completed with these organisms which, in the last analysis, constitute a parallel living world.

Evolution of Operations and of the Gesture

For these reasons there may be some benefit in adopting and sustaining the same attitude toward the whole of human evolution. Proceeding from the very general biological phenomenon of evolution employing earlier stages to serve as the active substratum for new, innovative ones, we have considered the evolution of the nervous system in terms of the addition of new cortical areas that led to the simultaneous emergence of technical motor function and of language and, later, to technicity controlled by mental processes and to figurative thought. It is already clear at the paleontological stage that erect posture and the general osteomuscular structure, once they have achieved human form in the Australanthrope, are no longer decisive. The hand, already formed in the monkey, stops changing (except for purposes of neuromotor adaptation) from the moment it begins to hold a tool. The decisive evolution of primitive anthropoids lies in the neuromotor equipment of the manual and facial cortex. From the osteomuscular point of view, nothing more takes place except adaptation accompanied by minor variations. The main thrust of evolution is massively oriented toward tools.

The actions performed by tools are relatively simple and few in number. The gestures of hammering, cutting, and piercing, which remain the stock-in-trade of hand manufacturing to this day, are quickly acquired. Evolution therefore became focused entirely on materials and forms of motion. The evolution of motion determined the freeing of motor function. Ever since the earliest agricultural societies, the conquest of force—together with the conquest of new materials—has been the dominant pursuit: conversion of rectilinear into circular motion, conversion of force through transmission, transfer of driving force from human to animal and, later, to the motor. The orientation toward new materials affected both the tool itself and the force that actuates it. Initially confined to metals, over the course of history it gradually created the problem of fuels directly or indirectly employed to drive machinery. Between the Bronze Age and the eighteenth century, advanced techniques evolved very slowly and with great difficulty, confronted with the problem of imparting more powerful motion to tools made of more resistant materials. With the solution offered by iron founding, motion and materials merged into a single cycle and everything became a matter of coal and steam. The prodigious leap forward of the nineteenth century was due to the fact that coal not only meets the requirements of iron founding and steelmaking but also provides the motive energy needed for mining and for operating machine tools. It thus fulfilled the conditions for a tremendous advance toward the freeing of force—and, as a corollary to this, challenged the whole inner structure of humankind. The consequences of coal for our way of life have been as important as a rapid transformation of the dental and digestive apparatus would be for an animal lineage. Railways and the emergence of a proletarian working class, to name only two of the immediate consequences of the freeing of driving power, have had a direct effect on the entire organization of our species. The adjustment of human individuals, whose brain and physical frame are still those of Cro-Magnon man, to the new conditions has involved an ever-increasing degree of distortion.

Today the process of adaptation is not yet complete. Evolution has entered upon a new stage, that of the exteriorization of the brain, and from a strictly technological point of view the mutation has already been achieved. From a more general point of view, the distance between ourselves—the descendants of reindeer hunters—and the intelligent machines we have created is greater than ever. The compression of time and distance, accelerated rates of activity, nonadaptation to carbon monoxide and industrial toxins, permeability by radiation—all these facts raise the curious problem of our physical compatibility with the environment in which we must now live. The conclusion to be drawn may well be that progress is beneficial only to society, while the individual human being is already an outdated organism, useful like the cerebellum or the rhinencephalon, like the foot and the hand, but already receding into the background to become the mere infrastructure of humankind in which "evolution" will henceforth be more interested than in the individual human being. Indeed, that would only confirm the identity of the human species with animal species, whose progress *as a species* is alone worthy of consideration.

Evolution of Operational Sequences

Technical liberation unquestionably reduces the technical freedom of the individual. From the Australanthrope to the age of mechanization, the operational behavior of individuals has progressively become richer, but its nature has not changed. The technical life of the hunter, and later of the farmer and the artisan, involves a large number of sequences that correspond to the many actions needed for their material survival. These sequences are empirical, borrowed from a collective tradition that one generation passes down to the next. Their principal trait, for all the unity of their broad outlines and their extension over vast polyethnic territories, is their strongly marked local and individual character. Everything humans make—tools, gestures, and products alike—is impregnated by group aesthetics and has an ethnic personality which even the most superficial visit to an ethnographical museum will reveal. Individuals introduce their personal variations into the traditional framework and, safe in the knowledge of belonging to the group, draw some of their sense of existing as individuals from the margin of freedom allowed them.

With the passage to industrial motor function, the situation changed thoroughly. The purpose of operational sequences was now to fill the gaps—still very wide—in the behavior of the machine. The worker was required to perform parts of sequences measured at the rhythm of the machine, series of gestures that excluded the worker as an individual. Complete "technical deculturation" took place, while at the same time the individual ceased to belong to a group of marked personality and comfortable size.

Early industrialization was followed by a process whereby the worker was gradually adapted to the machine without the latter's losing any of its preeminence. The "Taylorization" of gestures was accompanied by the standardization of tools and products, intensive adaptation to continuous circular motion (of rotary tools, lathes, spindles), and undifferentiated processing of different materials. Then mechanical automatism gradually came in, the worker's activity becoming confined to supervising the input of feedstock, executing the program, and delivering the finished product.

There cannot be any value judgments made about an evolutive process. We may think that the gigantism of dinosaurs in the Mesozoic era was "bad" because the dinosaur vanished while the crocodile survived, but we know nothing about the future of whatever it is that will replace *Homo sapiens*. What we can do, being far enough advanced in the present stage of evolution, is measure those things that have already changed beyond retrieval. From Pithecanthropus to the nineteenth-century carpenter, operational sequences remained essentially the same: Workers considered the materials they were to process, drew on traditional knowledge to select a certain series of gestures, and then manufactured and possibly rectified the products of which they were the authors. Throughout the process, their expenditures of muscular effort and of thought were in balance. However mechanical their behavior, it involved the "outcropping" of images and concepts and the presence—however shadowy—of language. For several hundreds of thousands of years, the human species–determined operational behavior was total, integrated in an immediately significant collective context and inseparable from the quality of humanness.

The possibility of feeding wood into a machine without paying any attention to the grain or knots and obtaining a standard piece of parquet flooring that will then be automatically packaged undoubtedly represents a very important social advance. But the only option it leaves to us is that of ceasing to be *sapiens* and becoming something else, something that may perhaps be better but will certainly be different. When we consider the ways open to us if we are to have some sense of existing other than the satisfaction of being a depersonalized cell within an organism (however admirably planetized that organism may be), we should remember that it takes more than a century or two for the zoological human to change.

The Fate of the Hand

The same facts can be verified from a different perspective that brings out another aspect of the mutation the human species has undergone. In preindustrial societies the individual level of technicity was relatively high: Putting it more precisely, the lives of all individuals were filled with manual activities of many kinds and of a quality at least sufficient for survival. The group made use of individuals of below-average ability as stopgaps, while virtuosos led in every field, offering a stimulating image to the rest of society: Artisans, musicians, or rich farmers, each little group had its share of models and maintained itself through contact with them. At the stage we have now reached, the ratio has changed very considerably, with vast masses of average and below-average people confronting an ever-diminishing number of models. Participation still exists, but it is exercised via the press or the audiovisual media: The following of the macrocollective model, whether astronaut, hero of labor, or Iranian princess, has no common measure with that of the master of the wolf hunt, the village blacksmith, or the local bartender, but the savor of proximity has gone, and the model's only value is as a purveyor of illusions.

The situation is quite similar if we consider the human hand. Originally it was a claw or pincer for holding stones; the human triumph was to turn it into the ever-skillful servant of human technical intelligence. From the Upper Paleolithic to the nineteenth century, the hand enjoyed what seemed like an interminable heyday. It still plays an essential role in industry, a few skilled toolmakers producing the operative parts of machines to be operated by crowds of workers requiring no more than a five-fingered claw to feed in the material or simply an index finger to push the buttons. But ours is still a transitional stage, and there can be no doubt that the non-mechanized phases of industrial processes are being gradually eliminated.

The dwindling importance of the makeshift organ that is our hand would not matter a great deal if there were not overwhelming evidence to prove that its activity is closely related to the balance of the brain areas with which it is connected. "Being useless with one's fingers," "being ham-fisted," is not a very alarming thing at the level of the species as a whole: A good number of millennia will pass before so old an organ of our neuromotor apparatus actually regresses. But at the individual level the situation is very different. Not having to "think with one's fingers" is equivalent to lacking a part of one's normally, phylogenetically human mind. Thus the problem of regression of the hand already exists today at the individual if not the species level. I shall revert to this question in part III in order to show that manual imbalance has already partially destroyed the link that used to exist between language and the aesthetic image of reality. It is not a matter of pure coincidence, as we shall see, that non-figurative art is flourishing at the same time as "demanualized" technicity.

9 The Expanding Memory

In the preceding chapter we considered the uniquely human phenomenon of exteriorization of the organs involved in the carrying out of technics. In that context it is not without interest to review the problems that arose when machines began to be endowed with the properties of a nervous system and a preestablished "consciousness" of their actions. The question of the relationship between the species and the ethnic group again arises in this context, but this time it does so in terms of instinct, intelligence and "artificial intelligence" or species-related memory, social memory, and "mechanical memory." To discuss a machine in the same way as a living organism may seem unwarranted. To do so from a purely zoological standpoint would be pointless, but some purpose is served, I think, by taking such an approach within an ontological perspective. We can then dispense with fractionating the human by choosing only those pieces that correspond to scientific systematology. Had Descartes, who opposed the human being as the embodiment of intelligence to the animal as a "machine," known about present-day electronics, he might well have spoken of the machine as an "animal." From a different point of view, we can refer to the obscure fantasies of the bulk of humankind. Reduced to their bare bones, the plots of newspaper cartoons and comics the world over always involve the same three characters—beast, man, and robot; where the cartoons are American inspired, the evolutive progression is, revealingly enough, the following: bison, gorilla, cowboy, scientist, astronaut, robot. Each of the main stages—beast–man–thinking machine—leads on to the next via the transitional stages of the thinking beast (gorilla), man-as-muscle (cowboy), man-as-brain (scientist), man-as-machine (astronaut), and machine-as-man (robot). That being so, the question arises whether the collective imagination might serve as the source for a classification that would help us to understand the evolution of the human community.

We have already commented on the fundamental fact relating to human memory: Like tools, human memory is a product of exteriorization, and it is stored within the ethnic group. This is what distinguishes it from animal memory, of which we know little except that it is stored within the species. Animal, human, and mechanical memory differ from each other in some essential respects. Animal memory is formed through experience within narrow genetic channels prespecialized by the species, human memory is constituted through experience based on language, and mechanical memory is constituted through experience within the channel of a preexisting program and of a code based on human language and fed into the machine by a human being. Mechanical memory is not without some points of resemblance to animal memory: A kind of species-related preconditioning exists in all types of machines, but the operating program is dictated in a wholly instinctive manner because it materially preexists the action, whose every twist and turn is plotted in advance. Seen in this light, the machine comes a good deal nearer to the standard definition of instinct than does the animal itself.

Within a functional perspective, then, the three forms of memory can be regarded as distinct but comparable. Human inherited memory is preexistent within the genetic group, and the reason why human beings do practically nothing "by instinct" is that, unlike animals, they have not received a hypothetical atavistic memory. The animal's experience uses a small keyboard that has been tuned in advance, leaving practically no room for personal variants, whereas human beings have a large keyboard at their disposal and can assimilate and embroider upon the many series of programs handed down to them by society. Seen from this angle, mechanical memory is halfway between the two in that the electronic machine uses only a small keyboard but receives an "education" in the form of the programs dictated to it.

Transmission of Programs

The history of the collective memory can be divided into five periods: that of oral transmission, that of written transmission using tables or an index, that of simple index cards, that of mechanography, and that of electronic serial transmission.

Oral Transmission

A group's body of knowledge is the basic constituent of its unity and its personality. The transmission of this intellectual capital is the necessary precondition for the group's material and social survival. Transmission is effected through the same hierarchy as operating sequences.

Mechanical operating sequences are part and parcel of the common memory of families. They are performed in all material and moral episodes of daily life and are recorded in the personal memory of individuals during childhood by means of processes in which the role of language is not necessarily the most important. The same cannot be said of less frequent or exceptional practices that, in all societies without writing, are stored in the memory of specialists—elders, bards, priests, who in traditional human groups discharge the highly important function of maintaining the group's cohesion.

The recording of knowledge is connected with the development of oral literature and of figurative representation in general; it will be dealt with in part III. In the most general sense practical, technical, and scientific knowledge is rarely recorded in literature of any kind, although it normally forms part of a context in which magical and religious matters are not clearly separated from practical ones. In agricultural societies and so far as artisanal tasks are concerned, the social structuring of crafts plays an important role: This applies as much to the blacksmiths of Africa and Asia as to European corporations before the seventeenth century. The training of apprentices and the preservation of craft secrets are taken care of within each of the ethnic group's social cells. At this level, which is that of primitive peoples as well as of quite recent agricultural societies, the contents of technical memory are not systematically organized in any way. To put it more precisely, each group of operating sequences—or each sequence—forms a more or less independent whole including actions to be copied as well as oral instructions.

Early Written Transmission

Writing did not spring into existence by chance; after thousands of years of maturing in systems of mythographic representation, linear notation of thought emerged together with metals and slavery (see chapter 6). Nor were the initial contents of linear notation a matter of chance: They were accounts, records of debts owed to gods or to others, series of dynasties, oracular pronouncements, lists of penalties. The limited and very poorly documented nature of the earliest texts is a constant source of disappointment to the ethnologist: How much more we would know if the Sumerians had left us some cookery recipes, hints on etiquette or woodworking, or metalworking manuals! But in point of fact it is unimaginable that writing should have been invented for such purposes, traditionally consigned to oral memory. The first concern of evolution is with the new, and in order to be felt as "new," early metallurgy itself would have had to fall completely outside the scope of existing mechanical practices. It would have had to be an exceptional operation unconnected with any established gestural sequence, which a manufacturing technique clearly could not be. Or else writing would have had to mature without an object for centuries in order to acquire the means of recording what had only recently become suitable material for notation, as unlikely a hypothesis as the earlier one. The collective memory would not have broken out of its traditional cycle at the birth of writing except in order to deal with matters that in a nascent social system were felt to be of an exceptional kind. Therefore it is not by chance that what was written down was not what is made or experienced in the normal course of events but what constitutes the very bones of an urbanized society where the nodal point of the autonomic system is the interchange between producers—be they celestial or human—and rulers. Innovation was concerned with the upper end of the system and selectively encompassed financial and religious acts, dedications, genealogies, the calendar—all those things within the new structures of the city that could not be completely consigned to memory either through gesture sequences or through products.

Only a few characteristic elements of science in its infancy were consigned to written memory. The earliest references of this order, whether in Mesopotamia, Egypt, China, or Precolumbian America, relate to the calendar and to distances. Primitive peoples before the settlement of agriculture did not lack knowledge about time and space, but both of these took on a new meaning from the moment when the capital city became the pivot of the celestial world and of humanized space.

As the instrument for storing words and phrases in the memory of generations became more efficient, the keeping of records developed and spread to deeper strata of knowledge. But even in classical antiquity, the sum total of facts that could be transmitted to future generations was limited by the hierarchy of social values to certain well-defined areas: religious, historical, and geographical texts, together with philosophy, accounted for the main bulk of written material. In other words, the basic theme was the connection between the divine and the human, and within that framework the material to be committed to memory concerned the threefold problem of time, space, and the human being. Agriculture cropped up in poems whose main subjects were the seasons, and architecture in descriptions where cosmic space was identified with palaces and temples. Mathematics and music, emerging at the same time as medicine, were the first scientific subjects in the full sense of the word, but they too were haloed with magic and religion.

Finding One's Way around a Text

Until the invention of printing, in the West as in China, the distinction between oral and written transmission is difficult to draw. The main body of knowledge was buried in oral practices and in techniques. Only the uppermost part of knowledge, its framework unchanged since antiquity, was set down in writing, to be learned by heart. During the centuries that lay between Homer or Yu the Great and the first western or oriental printed manuscripts, the concept of reference developed together with the growing mass of recorded facts. But each piece of writing was a compact sequence, rhythmically broken up by seals and marginal notes, around which the readers found their way like primitive hunters—by following a trail rather than by studying a plan. The spoken word had not yet been converted into a system of orientation tables. We saw earlier that the conversion of the two-dimensional mythogram not reducible to a phonetic phrase into a linear series of alphabetic signs represented the freeing of speech and at the same time a certain restriction of the individual's symbolizing power: With the advent of printing a further conversion, soon to become indispensable because of the abundance of texts, began to take place.

The texts set down in ancient or medieval manuscripts were intended to be committed to the reader's memory for life, at least firmly enough to enable readers to find their way around the manuscript with ease. There was also of course written material of a more mundane kind—letters and contracts, just as in the earliest days of writing but involving larger sections of the population—but these were kept in the possession of the persons concerned or of notaries, and practical problems of orientation did not arise. The same is by no means true of printed matter, which soon went beyond the range of traditional subjects. Readers not only obtained access to an enormous collective memory whose entire contents they could not possibly register but were also frequently confronted with new material. A process of exteriorization of the individual memory then began to take place. The work of finding one's way around printed material was done from outside. For centuries, dictionaries and glossaries had offered some possibilities of orientation; Chinese writing with its phoneticized mythograms, as well as the Greek and Latin scripts, had provided readers with means of orienting themselves along the traditional thread of successive ideographic or phonetic signs. But the dictionary provides only a narrow outlet for written memory, a form of knowledge that is both linearized and fragmented and therefore incompatible with the processes of sustained thought.

The eighteenth century in Europe marked the end of the ancient world in printing as well as in technology. It saw the old tradition at its richest as well as the first stirrings of the process of change still going on today. Within the space of a few decades the social memory had engulfed in books the whole of antiquity, the history of the great peoples, the geography and ethnography of a world now definitely acknowledged to be round, philosophy, law, the sciences, the arts, the study of technics, and a literature translated from twenty different languages. The ever-widening stream still flows today, but at no moment in human history did the collective memory dilate more rapidly than in the eighteenth century in Europe. This is why all possible methods of equipping readers with a preconstituted memory were already to be found at that time.

The dictionary reached its limits with the encyclopedias of every kind that were published for the use of manufacturers or artisans as well as of pure scholars. In the latter half of the eighteenth century, technical literature began to flourish. Every subject was explored, and the descriptive vocabulary still in use today began to form. The dictionary is a highly developed form of external memory in which thought is broken down into an infinity of fragments; the "Great Encyclopedia" of 1751 is a series of short manuals encased in a dictionary. The level of the art of documentation was then as high as that of mechanical animation: The automaton reached its peak when actuated by separate cams that endowed each of its organs with a fraction of memory; the encyclopedia is a fractional alphabetically arranged memory each of whose isolated mechanisms contains an animated part of the whole of memory. The relationship between Vaucansson's automaton and the French encyclopedia—its contemporary—was the same as that between today's electronic machine and integrated memory.

In sequentially arranged works the eighteenth century made use of practically every known method, in particular the medieval method of the marginal note (which still survives today) in order either to sum up a paragraph or to provide references, with the latter being more often consigned to footnotes. An alphabetic index at the end of the volume, already fairly common in the sixteenth century, became an almost standard feature.

The most interesting development from our point of view was the direct opposite of alphabetical indexing and affected the contents of the work as a whole. As early as the Middle Ages, and more or less universally from the sixteenth century onward, the margins of a book had served to provide summaries of the contents of each page or paragraph, and a brief list of contents had been supplied (without pagination) at the beginning of the volume. Little by little book presentation began to be organized in such a way as to help readers find their way around an unfamiliar volume. That is exactly the function of an external memory. The process took place along two tracks, each developing until the early twentieth century. One consisted in having each chapter preceded by a summary, the other in including a table of contents before or after the main body of the work. The former was a residue of the old attitude whereby a considerable personal memory input was expected from readers and, barring a few exceptions, has today disappeared. A summary at the head of each chapter after a list of contents at the head of the volume was a logical stage in the detailed discovery of the volume's contents, but the trend has been to turn the table of contents into something resembling a mythogram—a significant assembly of symbols in which the eye and the intelligence are not obliged to follow the rectilinear progress of the written text. To achieve this status, the table of contents has had to divest itself of all syntactic elements and now contains only freestanding words that serve as signposts for readers. In the sphere of printed matter, we have not gone any further than this point, first reached two centuries ago. As in all other spheres the spearhead of evolution has shifted; it is no longer in the book, which survives as the documentary infrastructure, but in documentary material freed from any context.

Index Cards

By the nineteenth century the collective memory had expanded to such proportions that the individual memory could no longer be expected to store the contents of whole libraries. The need became apparent to organize the inert "thought" contained in the printed "brain" of the collective by means of an additional fabric upon which a highly simplified picture of the contents could be projected. Above all else, the constituent cells of this new fabric had to be capable of indefinite enrichment and reconstruction in a manner appropriate to every type of documentary research. The eighteenth and part of the nineteenth century had still made do with notebooks and catalogs. These methods were succeeded by the card index, which did not begin to be properly organized until the early twentieth century. In its most rudimentary form it already represents a real exteriorized cerebral cortex: A simple set of bibliographical index cards will lend itself to many adaptations in the hands of its user, becoming an author or subject index, a geographical or a chronological one with every possible permutation to meet requirements as particular as the place of publication or the dimensions of inset plates. This is still more obvious in the case of card indexes containing scientific information, where each documentary component can be rearranged at will in relation to all other components. Actually the parallel with the cerebral cortex is in some respects misleading, for if a card index is a memory in the strict sense, it is a memory lacking its own means of recollection and has to be brought into the researcher's visual and manual operating field before it can go into action.

Punched Cards and Electronic Memory

A further step forward was taken by making the card index contain several sets of cards, perhaps of different colors, so that a second network of references was added to the first basic one, or—better still—by using punched cards. Books in their "raw" state are comparable to hand tools: However sophisticated their presentation, the reader's full technical participation is still required. A simple card index already corresponds to a hand-operated machine: Some of the operations have been transformed and are now contained in potential form in the index cards, which are the only things the reader needs to activate. Punched index cards represent yet another stage, comparable to that of early automatic machines. Whether they are cards with marginal perforations that have to be activated by hand or cards of some other kind requiring mechanical or electronic sorting, the principle of the punched-card index is always the same: The data are converted by means of a binary code (positive = no perforation, negative = open perforation), and a sorting device separates the cards according to a set of questions, releasing only those that produce an affirmative response. The principle is that of the Jacquard loom, and it is curious to note that documentary material waited for more than a century to follow in the footsteps of weaving. But although the mechanism is the same, the degree to which it is exploited is entirely different. The punched strips of the weaving loom express answers, whereas each perforated index card corresponds to a possible question. A punched-card index is a memory-collecting machine. It works like a brain memory of unlimited capacity that is endowed with the ability—not present in the human brain—of correlating every recollection with all others.

No progress beyond this stage has so far been made except in the matter of proportions. The electronic brain, although it employs different and more subtle processes, operates on the same principles. Theoretically devices using perforations or integrators (generally associated with the former) can compete with the brain in terms of the ability to compare. They can—on a gigantic scale and within a negligible period of time—process a mountain of data to achieve a well-defined end, and they can produce every possible answer. If provided with the data needed for an oriented choice, they can weigh those answers and enrich such preestablished weightings with judgments based on experience drawn from precedents stored in their memory. The electronic integrator's superiority over the card index is derived from the amount of data it can process within a very short period through the simultaneous action of several selection centers capable of checking and correcting their own output, whereas the most efficient cards in existence, having a data density of 20,000 per card or 10,000,000 per 500 cards, still require the operator's direct participation and considerably more time. The artificial brain of course is still in its infancy, but we can already be sure that it will be more than just a nine days' wonder with limited applications. To refuse to see that machines will soon overtake the human brain in operations involving memory and rational judgment is to be like the Pithecanthropus who would have denied the possibility of the biface, the archer who would have laughed at the mere suggestion of the crossbow, most of all like the Homeric bard who would have dismissed writing as a mnemonic trick without any future. We must get used to being less clever than the artificial brain that we have produced, just as our teeth are less strong than a millstone and our ability to fly negligible compared with that of a jet aircraft.

The tradition that holds the human brain responsible for human achievements is a very old one. The human species adjusted with equanimity to being overtaken in the use of its arms, its legs, and its eyes because it was confident of unparalleled power higher up. In the last few years the overtaking has reached the cranial box. Looking facts in the face, we may wonder what will be left of us once we have produced a better artificial version of everything we have got. We already know, or will soon know, how to construct machines capable of remembering everything and of judging the most complex situations without error. What this means is that our cerebral cortex, however admirable, is inadequate, just as our hands and eyes are inadequate; that it can be supplemented by electronic analysis methods; and that the evolution of the human being—a living fossil in the context of the present conditions of life—must eventually follow a path other than the neuronic one if it is to continue. Putting it more positively, we could say that if humans are to take the greatest possible advantage of the freedom they gained by evading the risk of organic overspecialization, they must eventually go even further in exteriorizing their faculties.

If electronic machines learned one day to write perfect plays and paint inimitable pictures, some serious questions would have to be asked about the future of the human species. By learning how to love they would definitively settle our hash as a zoological species. Before we project into the future a picture that may well be false, I propose in the last part of this book to consider an area as yet untouched by the machine, for we have all along gone round inside a triangle formed by the hand, the word, and the sensory-motor cortex and have shuttled back and forth between the human and the monkey in search of what cannot be shared with the rest of the zoologically or mechanically animated world.

III Ethnic Symbols

10 Introduction to a Paleontology of Symbols

In the first part of this book we often spoke about the evolution of the human body, the physical "fund" of humanity. Having defined the two major criteria of technicity and language against the background of their common origin, we became aware of the close links between human evolution and a broader zoological context. The second part dealt principally with the collective entity of the cultural group. Technicity and language were viewed no longer in a zoological perspective but as phenomena subject to evolutionary laws which, although developing far more rapidly, run parallel to those of zoology. Human evolution was seen to be coherent in terms of its two fundamental characteristics of manual and verbal technicity although in a sense dissociated into two levels, that of phyletic evolution—as a result of which present-day peoples are a collection of individuals with physical properties hardly different from those possessed thirty thousand years ago—and that of ethnic evolution, which has turned humankind into an exteriorized body whose properties are globally in a state of accelerated change.

Beyond this dual image of the human machine and its improved artificial copy lies something else. Analyses made thus far have deliberately left out of account those things that constitute the fabric of the individual's relationship with the group—that is to say, everything that has to do with aesthetic behavior. A survey of relationships of individuals with each other and with society reveals the existence of certain functional formulas—such as marriage or economic exchange—that are no more than the expression of the fundamental physiology of any society, a physiology that is reducible to the laws of the species or the social group but that fails to reflect what is specific to each human collective. The distinction between species and ethnic group was seen to be necessary because members of the human zoological species combine in units that are clearly not zoological in character. But the characteristics of the ethnic group were studied only in so far as they fell within the scope of the functional formulas. The rules of particularization that govern everything that is specifically human in us were left outside the technoeconomic schema, and these rules still remain to be defined.

In the preceding chapters we found ourselves gradually stripping the human of some of traditional human attributes in the attempt to demonstrate that human beings as a mass constitute a social macroorganism capable of employing individuals to develop thinking machines that can think more quickly and more usefully than they. For a missile made by a large number of individuals to destroy a long way away a sufficient number of individuals, no individual can calculate quickly enough the trajectory to make the operation profitable for the collective that dispatches the missile; an artificial brain can do so. The question that arises is what is left of us at the end of such an evolution. Does our species still retain a sense of the beauty and goodness, an unsurpassable affective quality from which the machine is excluded forever, or merely the ability to reproduce artificial machines, using an ingenious combination of male and female elements to generate the indispensable machine makers?

We should not be too quick to assert that machines will never appreciate beauty and goodness. They can already reduce truth to sets of unassailable data, and will probably soon be able, not perhaps to tell whether representational painting is preferable to abstract painting, but to set out the statistical relationships between the respective contents of the two in such minute and ingenious detail that all artists will need to do will be to collect printouts telling them what subjects, what forms, dimensions, details, what frames will maximize their chances of appealing to the potential viewer's attention, sense of form, and possibly even cultural snobbery. It will become possible to make a robot portrait of the piece of sculpture that will best lend itself to financial speculation over the next three generations or one that will have the best chances of surviving the hazards of international transport or nuclear damage. Already we have the right to ask ourselves which parts of the osteomuscular system of *Homo sapiens* will stand up to an analysis of fourteen million good deeds that will reveal our dominant physiological motives, the derisory banality of our feelings of greatness or justice, their hormonal motivation, the threadbareness, finally, of the whole vast carpet of humanity which, illuminated here and there for the space of three or four generations, has been unrolling since the beginning of time. Apocalyptic writings sparkle with mysterious numbers: The electronic apocalypse for its part is entirely made up of numbers whose demystifying power is immeasurable. There may be some interest in going over the long story of evolution yet again, not in order to ask whether evolution has a meaning (one day, the machine will tell how many chances out of how many billion the human adventure had of ever taking place), but whether we still have a meaning other than as creators of superhuman machines. That is my object in trying to write these last chapters.

Aesthetic Behavior

The term "aesthetics" is employed here in a rather wide sense that requires some preliminary explanation. We are indeed concerned with the subject that in philosophy is the science of the beautiful in nature and in art, but we are concerned with it from the viewpoint adopted from the beginning of these pages, that is to say, within a paleontological perspective in the general sense, a perspective in which the dialectical two-way traffic between nature and the arts pinpoints the twin poles of the zoological and the social. Within such a perspective the concept of the beautiful cannot be restricted only to the auditive and visual emotivity of *Homo sapiens;* instead, we must consult the whole gamut of our perceptions in order to discover how a code of emotions to which the ethnic individual owes much, if not all, of his or her affective integration in society came to be constituted in time and in space.

This aesthetic code of emotions is based on biological properties common to all living organisms, properties of the senses that afford a perception of values or rhythms or, more broadly still and including the simplest invertebrates, which afford some reflex-related participation in rhythms and some reaction to variations in values. In humans the gradual intellectualization of sensations has led to conscious perception and production of rhythms and values and to codes whose symbols have an ethnic significance, such as those that govern music, poetry, or social relations. Aesthetic phenomena emerge at different levels, some having the same significance in all human societies while others—the great majority—are fully significant only within a particular culture.

Appreciations of food, architecture, dress, music, and so forth, form the essence of a culture and symbolize the distinctions between ethnic groups. Take away the penumbra of values and all that is left of a cultural trait of any kind becomes impersonal and interchangeable. The particularizing function of aesthetics rests upon a basis of mechanical practices having in-depth links with both the physiological and the social apparatus. Much of aesthetics has to do with the humanization of forms of behavior common to animals as well as humans (such as feelings of comfort and discomfort), with visual, auditive, or olfactory conditioning, and with the intellectualization, through symbols, of biological links with the natural and social environment.

Aesthetic feeling may express itself at the level of an activity pertaining to bodily functions, as with taste; of technical activities, as with gestures employed in the course of exercising a craft; of social life, as in codes of polite behavior; or they may be reflective or figurative, as in the arts or in literature. These different levels—*physiological, technical, social, and figurative*—will serve us to define the broad areas within which human sensations are ordered. The reference points of human aesthetic sensibility are found in deep visceral and muscular sensibility, in the sensibility of the skin, in the senses of smell, taste, hearing, and sight, and lastly in the mind's eye which symbolically reflects the whole fabric of sensibility.

It might seem more in line with aesthetic reality if we limited its scope to symbolism, seeing in its various expressions only what is uniquely human, namely the ability to create images of the outside world reflected in the mind and materialized in artistic creation. In other terms, it might suffice if we took figurative representation to be the basis of aesthetics and argued that the reason why, for example, the notion of physical comfort is not the same in China as it is in Japan is not physiological but that social and artistic norms imprint certain attitudes upon the individual and the resulting habit eventually expresses itself in sensations of comfort. Similarly we might argue that the aesthetics of polite gestures are not based on social cohesion but reflect a certain image of the behavior of an educated individual, modeled on ceremonial art, with the individual playing the role of the polite person.

But if we proceeded in this manner, we would lose the paleontological perspective. Our only sure source for conjecture about the aesthetics of Archanthropians lies in physiological value judgments: from the carnivore or the primate to the modern human, we find in the senses of taste, smell, and touch a common ground that allows us to make comparisons, especially as no figurative activity can possibly be involved. At the Archanthropian and Palaeoanthropian level, the only coherent evidence suggests a sense of balance in the efficient shapes of tools, a manner of organizing specifically human functional values that involves aesthetic assessment but does not lead to figurative symbolization of any kind: A picture of a smithy is no more a functional symbolization (which cannot be achieved otherwise than in the function itself) than a cardboard meal on a theater stage is a figurative representation of taste. It cannot be denied, however, that value judgments can be made in both areas and that the standards resulting from those judgments are neither wholly technical nor moral but aesthetic in nature. The conclusion to be drawn is that although in *Homo sapiens* the peak of aesthetic sentiment is no doubt to be found in figurative representation while physiology and technical functionalism account for its deeper reaches, we must first investigate those depths that alone are paleontologically sure if we want to study the transition to higher forms and, above all, if we want to study such archaic matter as those forms may still contain. We cannot claim to understand the trends of modern abstract art as a "return to the source" until we first elucidate the nature of that source.

In the social sphere the problem is somewhat different. Animal sociology is sufficiently advanced for us to be able to compare, say, attitudes of deference among wolves, the courtship displays of birds, the recognition of characteristic features of young males or females, or the periodic assemblies of numerous animal species with similar features in the social behavior of human beings. Without language coming into play at all, the color of an individual's tie will show his position within a human group as precisely as the robin's red breast in a society of birds. But unlike physiological or technical features, the wearing of a vestimentary distinguishing mark is a symbol that gives rise to several social images at once. As a characteristic of function it lies just inside the technical range; as a portable and conventional badge it comes very close to figurative representation. That is why we have placed social aesthetics at the point of contact between the technical and the figurative spheres.

Beyond that lies nothing but images, and we have subdivided these in an order suggested by physiology and by the level of their integration. Motor figurative representation (mimicry and dance) comes first, for the gesture inseparable from language must have followed the early development of language, coming to the surface in the form of figurative representation at a very early stage. Next come auditive representations (music and poetry), whose connection with gesture (in the case of music) and with speech (in the case of poetry) places them in a position halfway to visual forms. These, such as painting, involve the human dominant sense, which is also the one where symbolization is farthest away from actual movement—where intellectualization has stripped the real forms of their contents and kept only the signs. Writing comes after visual aesthetics, its images being purely intellectual and its symbols completely interiorized.

The status of language at each stage of this sequence is interesting. Of all branches of philosophy, aesthetics has always found it most difficult to find expressions in words. When it succeeds, it is by evocation, by relying on the reader's imagination and experience to supply the sounds, forms, and gestures that words can conjure up but not reconstitute. Language, it seems, is not adequate for expressing the aesthetic. The marvelous thing about poetry is that it creates an ambiguity between its rhythm and the words that that rhythm carries. The words of a song are the less intelligible, the more the song is really music; it is as though the vocal function served not only intellectual expression but also something else in which intelligence, the faculty of understanding, plays no part.

It seems that the conquest of tools and of language accounted for only a part of the human evolution and that aesthetics—in the sense employed here—played an equally important role in the ascent. But whereas paleontology supplies us with fairly detailed means of reconstructing the successive states of the brain and the hand, with knapped flints giving us a clear view of technical evolution, it is hard to see how we can possibly isolate and identify something that is not imprinted either in the human skeleton or in human-made tools.

In trying to outline a paleontology of language we drew upon the constant presence of a facial and manual anterior field and the cerebral connection between the motor functions of the facial and manual apparatus. The advent of figurative representation, followed by that of writing, provided a means of checking this connection, which goes back some fifty thousand years. An attempt to study the evolution of aesthetics has to be based on something different.

The physiological/technical/social order, as discussed earlier in this book, is a very general biological schema applicable to the life of an insect as much as to that of a rodent or a human, since all species, even parasites, display—for a time at least—sufficient technicity to ensure a supply of food and as much social behavior as will assure their reproduction. This schema therefore represents the substratum upon which aesthetic behavior must of necessity be implanted. Just as in technics we have seen facts deeply rooted in zoology become specifically human in the course of evolution, just as in language we find facts of interindividual relationship implanted deep inside the mass of living species now bathed in the light of human intelligence, can we see the perception and creation of rhythmic symbols as something deeply rooted in the animal world which—on emergence at the human level—displays the same characteristics as technics and language? To put it differently, since the technical function in human beings exteriorizes itself in portable tools and since the perceived object too is exteriorized in a verbal symbol, can we assume that movement in all its forms—visual, auditive, and motor—was also "freed" and entered upon the same evolutionary cycle?

As with technics and language there are different degrees: The purest art always plunges deepest; only the uppermost tip emerges from the plinth of flesh and bone without which it could not exist. I believe that although a paleontology of symbols might have more to do with psychoanalysis than with comparative anatomy, the principle of creating one should at least be debated.

To define the relationship among technics, language, and aesthetics is important because the interdependence among these three fundamental traits of humanity is not in doubt. The relationship may reveal itself in different ways. We could suppose that language and technics form the indispensable "fund" sufficient for survival, and that aesthetics came to be gradually superimposed upon them like a coat of paint, having been independently acquired at a late stage of evolution. According to that hypothesis the aesthetic sense, starting from the high peaks of figurative art associated with the late Paleolithic, would gradually have spread down toward its roots until in our own epoch it would be beginning to overlap the physiological. Such a hypothesis would postulate the particularity of the aesthetic sense, obliging us to find out where that sense fits into the mechanism of our brain, on the assumption that, besides the ability to create an abstract language, something else was at some stage added to our cortical apparatus to create new relationships between images. Arguments in support would not be hard to find, for an enrichment of aesthetic responses can be observed in the technical sphere as well as in tactile and olfactory perception; but how might it be proved that this process of enrichment was confined to artistic form rather than being a globally comprehensive one?

The other hypothesis we could adopt is that since technics and language are but two aspects of the same phenomenon, aesthetics could well be a third. We should then have something to guide us, for if tools and words developed into machines and writing by similar stages and more or less simultaneously, the same phenomenon ought to be observable in the case of aesthetics: From the pleasure of digestive satisfaction to that of handling a handsome implement, from the sense of music expressed in dancing to watching a ballet from a theater seat, we should be able to detect the same process of exteriorization. Stages in aesthetic evolution comparable to the transition from the mythogram to writing and from the hand tool to the automatic machine would have to be found in historic times—an "artisanal" or "preindustrial" period in aesthetics in which the arts and social and technical esthetics had reached their peak at the individual level, followed by a specialization stage in which the disproportion between the producers of aesthetic material and the increasingly large mass of consumers of prefabricated or "prethought" art became accentuated. This second hypothesis corresponds more closely, if not to the whole reality, then at least to the general direction in which the biological facts seem to point, and it is the one I shall endeavor to demonstrate because it brings to the problem of ethnic grouping an element that a theory based exclusively on technics and language would lack.

Ethnic "Style"

No description of ethnographic facts, however detailed and precise, can account for what is most real in an ethnic group's value. We can describe a type of object, an agricultural practice, a belief that may belong to just one specific group; we can add them together to obtain a formula that will characterize that group without any risk of confusion. But the major part of culture is made up of traits that belong to humankind at large or to a continent or, at the least, to a region composed of many groups, each of which feels different from the others. The ethnic particularity that transforms a simple enumeration of axes, bellows, or matrimonial arrangements into an expression of a people's "spirit" does not lend itself to verbal classification; it is a style that has its own value and that pervades the group's culture as a whole. Precisely like the connoisseur who recognizes the very vineyard from which a particular wine has come, the trained ethnologist, helped by harmonies of forms or rhythms, will tell the products of one culture from those of another. The process is empirical, and it can be imagined that electronic analysis will one day reduce the undefinable flavor of each ethnic group's works to a few equations. But that does not alter the fact that style, unlike technical or linguistic characteristics, is inaccessible to ordinary language. A detailed mechanical analysis can explain how the engines of English motor cars differ from those of French or Russian ones, although the fact of being a motor car is common to them all. An analysis on a gigantic scale would have to be performed in order to explain why the observer can tell at a glance that a car is "typically British." Similarly the "New Orleans" style in jazz has become part of our common heritage and should in theory be invariable; the ear can tell, however, whether the same item is being performed by a Swedish group rather than an American one. If ethnology is thus incapable of formulating what is the central object of its study, it must be missing something in a field that has nothing to do with language but is important enough to contain the ethnic group's reality. This fact is common to several branches of natural science, of which the study of the human and of human products is one. Racial anthropology has all the outward characteristics of an exact science, yet a practiced anthropologist will take only a second to recognize the geographical origin of a skull and then spend weeks demonstrating it scientifically—a demonstration, incidentally, from which most of the factors on which the initial spontaneous identification was based will be absent.

In zoology weather has been found to determine a certain genetic orientation in nonnomadic species. This orientation, which may be of greater or lesser importance, is reflected in the emergence of local variations, often of a subtle and fluctuating nature and liable to become rapidly diluted through contact with other populations of the same species. The same is true of cultural characteristics. They are based upon what may be a very broad common stock, become particularized in any reasonably coherent group, and produce local variations, sometimes very slight, that come and go at the whim of history. This "play" affects minor technical and social innovations as well as forms of all kinds and in every possible area, from the curvature of a hoe handle to ritual practice.

This interplay, thanks to which no human group is exactly like another and all ethnic units are different from all others and from themselves at any two moments of their existence, is extremely complex. Individual innovation, although predominant, is so only in terms of the direct influence exercised by preceding and contemporary generations. Moreover the degree of consciousness varies with the level of the innovations, in the same way as it does in the case of technical operating sequences. Everyday forms are subject to a slow process of unconscious adaptation, as though common objects and gestures were being gradually molded to the changing attitudes of a collective whose membership is homogeneous. Exceptional forms, on the other hand, undergo real mutations in groups where individual invention is not hampered by an excessively rigid tradition. At one end of the scale we see domestic or agricultural practices or objects and the tools and gestures of artisans gradually assuming rhythms and forms that isolation makes increasingly characteristic; at the other, festive costumes or ritual dances may show sudden and in many cases marked changes between one event and the next.

In day-to-day practices and in their setting, the marks of style are deep because they lie outside the scope of conscious awareness. As with technical operations they persist through the lives of several succeeding generations. The ethnic "tonalities" of certain attitudes, certain gestures of politeness or communication, walking rhythms, dietary and hygienic customs, are transmitted from one generation to the next. In figurative practices such as music, dancing, poetry, and the plastic arts, there is a clean break between the basic practice and its individual variations because the operating stages of figurative representation do not change: The bare bones of figurative representation in, say, music or painting may remain the same for centuries precisely because of the possibilities they offer to individuals for introducing personal variants without altering the basic structure.

This deep-rootedness of aesthetic practices goes to confirm the method we have adopted. Physiological actions occupy a predominant place in day-to-day operations; they not only form the paleontological substratum but also are the area most often visited by living individuals. The motor elements of figurative representation are closely connected with physiological actions. Technical actions—the whole of "functional" aesthetics—also play a most important role in the most commonly performed operational sequences. But in their case the level of conscious intervention is higher, and there is more scope for exceptional innovation. The fact that neither physiological nor technical actions can conceivably be integrated in figurative activity makes their substratal nature even clearer.

The social element is of pivotal importance, for two reasons. First, social operations are performed with every possible degree of frequency and with degrees of stylization ranging from the mechanical gesture of buttoning one's coat in order to be properly dressed to the elaborate ceremonial that governs the reception of a head of state. Second, they involve levels of mechanical action that range from the purely physiological, such as our bearing, to abstract symbolism in our handling of figures or of the calendar. Thus the physiological, the technical, and the social clearly correspond to three successive levels as regards operating practices, but in the case of figurative practices, which have their own order of development parallel to that of language, the same succession is not observed in the same form.

Ethnic style may then be defined as a collective's own way of adopting and expressing forms, values, and rhythms. Seen from this angle, aesthetic personality becomes less elusive, and an analytical method as precise as those used in technology or descriptive sociology can be posited. Ranges of tastes, odors, feelings to the touch, sounds, or colors are extremely wide and differ greatly from one group to another. The distance that separates natural postures from those adopted in society within a given culture is a measure of the collective's tolerance; the shape of tools lends itself to precise functional analysis, as does the integration in space and time of individuals in their domestic and broader environments. In addition the means of investigation employed in the arts are also available. Indeed they ought to be organized for the purposes of comparative research, for ethnic style involves every form of expression. At the summit of poetic art we merely find ourselves at the head of a procession whose rearguard is still submerged in the hormonal darkness. Faced with a sculptor at the very peak of his or her personal genius, we are still dealing with a certain individual, member of a certain ethnic group, brought up in a certain social environment, the spokesperson—so far ahead of the rest that he or she may sometimes look like being completely alone—but nonetheless the spokesperson of an Oceanian, Chinese, or Turkish collective reality.

The third panel of the ethnological triptych is no less revealing than the two others, but its ambience is completely different. We can discuss technics and language—and, later, social memory—without introducing any value judgments. The facts we deal with are there or not there, they evolve in coherent sets to give us a degree of efficacy which overall is increasing. In them the social element predominates by far over the individual, and evolution knows no criterion other than that of collective benefit. The resonance of aesthetics is altogether different; here society predominates only in order to give individuals a sense of their personal existence within the group. The aesthetic sense is based on judging nuances. It orients our choice toward a conformism as strict as that of technics, but a conformism of a different order because it is produced by an opposition between values to which the individual's integration in society offers the solution. The use of an ax does not involve judgment. The ax is necessary or it disappears, replaced by the mechanical saw. But the aesthetic halo surrounding the efficient shape and movement of the ax is created by every individual who judges goodness and beauty, not as an absolute, but within the safety of the aesthetics of his or her group and the imaginary freedom of his or her choice.

11 The Body as the Source of Values and Rhythms

If we agree that the aesthetic sense rests upon a consciousness of form and movement (or of values and rhythms), which is peculiar to the human being because only the human is capable of formulating a value judgment, we must for the same reason inquire into the sources from which we draw our perception of movement and form. A mammal like many others, although with a cerebral apparatus of unique complexity, the human is not known to have any organ of perception not shared with the rest of the mammals. Our sensory equipment, placed at the service of a marvelous apparatus for transforming sensations into symbols, functions like the sensory equipment of animals; their mental life lacks our symbolizing equipment, but our sensory life includes every feature of theirs. We obey the rhythms of our digestion, we feed at fixed times, in a crowd, we obey the collective rhythm like a sheep; our tastes in food are based on the same organs as those of a fish, our muscles flex and relax without our consciousness coming into play. In short, the human animal mechanism functions at several levels which, except for intellectual integration, are the same as those of other living organisms. We could take the a priori view that intelligent symbolization can have a reflex action and that everything in the human being is therefore assimilable to the workings of aesthetically constructive thought. Or, conversely, we could ask ourselves whether aesthetic thought does not stop where "natural" behavior starts. Of these two hypotheses, the former seems to me closer to the position we have adopted thus far. In supporting it, we should have to concede that while our mind does in fact ensure a certain consciousness of our lived experience, the activities of some parts of our sensory apparatus must always remain infrasymbolic: This, for example, is the case with taste in the strict sense of the word, which cannot be rendered by anything other than itself. You cannot create an image of a salty taste.

The Sensory Apparatus

In animals, the simplest forms of behavior can, from the sensory point of view, be reduced to three levels: that of feeding behavior, which ensures the functioning of the body by processing materials assimilable by the organism; that of physical affectivity, which ensures the genetic survival of the species; and that of integration in space, which makes the two others possible. These levels, which are diversified according to the degree of evolution of each species, correspond to three levels involving the relationship of individuals with one another and with their environment. The aesthetic implications of these three levels are still observable in humans; we could describe them as "physiological aesthetics." They bring into play, in varying proportions, all the instruments of the sensory apparatus: visceral sensitivity, muscular sensitivity, taste, smell, touch, hearing and balance, and sight.

Each of these elements forms part of a dynamic whole whose basic machinery is the same in animals and humans. Visceral rhythms are the driving force of feeding behavior, while smell, taste, and touch are the agents of perception. Affective behavior is determined by perception of the play of the muscles as well as by touch, smell, and sight. Behavior pertaining to one's position in space and time is served by the organs of balance, and perception of the body in space is determined by reference to the dominant sense, which in the human is the sense of vision and in other species the senses of smell, touch, or hearing. None of the three levels of relationship with the external environment is conceivable without a certain rhythmicity of the body and without a reference mechanism. Taste without nutritive activity is an abstraction, affective acts expressing sympathy or aggressivity are entirely a matter of the connection between perception and the movements it determines, and integration in space exists only to the extent that the physical body perceives space. In other words, association of movement with form is the primary condition for all active behavior.

Whether animal or human, active individuals have their being within a network of movements that originate inside or outside their body mechanism and whose form is interpreted by their senses. Broadly speaking, individual perception intervenes between external rhythms and an individual's motor responses to them. The movements of the marine annelid as it ascends and descends with the tides inside its tube are determined by its sensory perceptions of taste and touch, which responds to temperature and vibrations. Its feeding behavior and its integration in space and time are the equivalent of its integration in the environment to which it belongs. At a much higher level, the mammal living inside its territory staked out by smells and sounds, sensitive to the alternation of day with night, to temperature variations and visual images, exists wholly within the synergy of rhythms and forms, the signals received by its senses, their interpretation and its own responses.

With human beings the situation clearly remains the same, with the difference, however, that it can be reflected in a network of symbols and held up for comparison with itself. Over the period of human evolution, rhythms and values thus reflected have tended to create a time and a space proper to humankind, to imprison behavior within a checkerwork of scales and measures, to assume concrete form in "aesthetics" in the narrower sense. Yet the biological infrastructure—our body—still uses the same means and has none other to put at the disposal of the artistic superstructure. The aesthetic sense in its reflected form must continue to be like the world from which it has sprung, with sight and hearing—the senses made dominant by our zoological evolution for purposes of reference in space—maintaining their primacy. Imagine the "syntacties" or "olfacties," paintings in smells, symphonies of touch, architectures of balanced vibrations, poems of salt or acid taste, we should have had if touch or smell or a subtle perception of vibrations had been our principal senses! All these aesthetic forms, though not completely inaccessible to us, have found only a modest place in our arts. It would be a pity, however, to deny them their place in the subterranean regions of our aesthetic life.

Visceral Sensibility

The ordinary functioning of our physiological mechanism seems destined to be overlooked. The perceptions relating to it are obscure and difficult to locate and cannot play any part in the process of aesthetic formulation. Yet Freud and the rest of the psychoanalytical school have demonstrated the importance of the libido and of frustrations clearly enough to prove that psychophysiological conditioning can affect the highest forms of aesthetic life—one might say especially the highest forms, for figurative creativity is the main element of individual liberation, whereas technical or social behavior is determined by collective norms that demand a degree of conformism.

The most important expression of visceral sensibility is connected with rhythms. The alternation of periods of sleeping and waking, of digestion and appetite, all such physiological cadences create a fabric upon which all activity is inscribed. These rhythms are generally connected to a wider fabric, that of the alternation of days and nights and of meteorological and seasonal changes. The result is a real conditioning that provides a steady basis for day-to-day operations but affects aesthetic behavior only inasmuch as its instrument is the human body. Visceral comfort matters only to the extent that it establishes the conditions for normal functioning; sickness or physiological deficiency can significantly modify the individual's aesthetic field, but only through the effects they exercise upon normal activity in general.

However, if we bear in mind that in all cultures many unusual motor or verbal phenomena occur as a result of individuals being "transported" to a mental state other than their normal one, we must acknowledge that disturbances of the rhythmic balance do play an important role. In exceptional rituals—ecstatic revelations, states of possession during which individuals dance or make music highly charged with the supernatural—one of the methods employed all over the world consists in putting performers outside their daily rhythmic cycles by breaking their physiological routines with fasting and lack of sleep. The end result may be excitement of the psyche, but the starting point is visceral. The change of register cannot be brought about unless it starts in the very depths of the organism.

Privation and Control

Interruptions of natural rhythms—prolonged waking, turning night into day, fasting, sexual abstinence—tend to evoke the religious rather than the aesthetic sphere because in modern culture these two spheres have become divorced from each other. That, however, is only a recent consequence of the evolution of the social organism, the outcome of a process of rationalization of which we are the promoters. At the social level an interruption of the normal cycle is equivalent to a decline in technical performance. Isolating the religious from the aesthetic spheres prevents the disruption of vital rhythms and puts the individual in a situation favorable to the smooth running of the sociotechnical mechanism. This fact has been explicitly or implicitly understood since Confucius and is applied on a decisive scale in modern societies. It presupposes the existence of a small number of virtuoso practitioners specialized in the art of living against the normal rhythms and, for the mass of humanity, the safety valve of events filtered and measured in time and space and consumable without serious disturbance of those rhythms. This is blatantly obvious in the steps taken in some Muslim countries to abolish the Ramadan fast as an obstacle to production and a little less so in the gradual easing of fasting rules by the Catholic church. We must repeat, however, that this is a recent development whose result cannot be projected back over the thirty thousand years in which human life was lived as a totality and physiological control provided the infrastructure for the great imaginative flights of the spirit.

At a different level it could be argued that the initiate was cold sober when he or she learned the dance and that it was a well-fed poet in a state of perfect mental lucidity who composed the verses chanted by the delirious crowd of pilgrims. But even if this were not generally incorrect—even if composition and performance were two completely different things—it would still not alter the facts. Aesthetic behavior is no more confined to the creation of a work of art than the blacksmith's forge is simply a matter of the invention of metallurgy. In any event the role of improvisation in practices that antedate writing is so overwhelmingly obvious that aesthetic production and consumption must be seen as intimately intermingled within the same field.

More important still are the methodical efforts made to break the cycle, to establish a quasi-permanent secondary state. The great mystical schools of India and China, of Islam and the West, have all tended toward physiological control, toward escape from rhythms through contemplation and control of the visceral apparatus. The most popular of such techniques of abstraction is yoga, in which the pursuit of rhythmic control involves all the organs, including the heart. The perfect yoga ascetic forms part of an aesthetic universe of ecstasy, all organs at peace, all rhythms of time and outward space abolished—an antithesis that, as we shall see, is not so different from what has led figurative art to abandon figurative representation. Taoism too has its techniques for escaping from the alternating cycle of the male and female principles, its rigorous dietary rules, its breathing discipline based upon a conception of the universe in which everything obeys rhythms of complementary values, a mobile frame of a cosmos the sage can slip into without brushing against anything at all, outside time and space. We shall reencounter the problem of our insertion between heaven and earth when we discuss the symbols of society. Here it is interesting to note that the sage's *dis*insertion begins with the digestive tract in a process of initial purification that eventually leads to being able to sustain oneself by swallowing nothing but air. To see the spirits that rule each separate organ, to discipline one's liver, to learn to retain one's saliva and one's vital secretions, to control one's breath, to still the whole physiological apparatus until one acquires a body made of jade—such was the dream, pursued for centuries, from which much of Chinese philosophy has sprung. We are still too close to see what our western arts owe to a certain conception of life that borrows its foundations from the pact between oneself and one's body. But in the way of life and the art works of classical China—because a sufficiently great distance separates us from it and also, no doubt, because the expression of that pact was there carried to an extreme—we can observe a continuity between the uttermost depths and the summit.

The superimposition of Buddhism upon Taoism has intensified the effort to escape from the circular rhythms of life on earth. In China, and later in Japan, a complete mode of ideal existence has been created in which the peaceful sage, having achieved complete control over his body, lives out his life in perfect harmony with wind, water, trees, and moon in a state of balance that starts with the stomach and ends with painting.

Muscular Sensibility

Unlike the skeleton, which in the normal state is not perceived, its drapery of muscle is the seat of strong impressions. Our osteomuscular mechanism may be regarded, not as a tool, but as the instrument of our insertion in existence. We must leave aside, as being an intellectual operation, the integration of movements performed within the motor cerebral cortex, but we should not fail to note the paleontological connection between the inner ear and the osteomuscular apparatus in ensuring the individual's balance with respect to the environment, in immediate perception of space, and in organizing movement.

The weight of the body is perceived by the muscles; it combines with spatial balance to hold us down in our concrete universe and, by antithesis, to constitute an imaginary universe from which weight and balance have been banished. Acrobatics, balancing exercises, the dance, are to a large extent the material expression of the attempt to break away from normal operating sequences and create something outside the day-to-day cycle of positions in space. Such a liberation occurs spontaneously in dreams about flying when the inner ear and the muscles are at rest and when sleep has lifted us outside the normal scene. In a different way we experience a sense of liberation during waking hours when we watch an acrobat throw off the shackles of operating logic.

The normal functioning of the intellectual apparatus as a whole is governed by the organic infrastructure, not only in terms of the satisfactory or poor state of the body machine but also, at every moment of our lives, in terms of the rhythms that integrate us in time and space. For animals as well as humans, balance consists in the coordinated play of organs and muscles according to rhythmic sequences of different amplitudes dovetailed into a regular order. A serious disturbance of internal or external rhythmicity causes neuropsychological behavior to diverge from the normal. In wild mammals in captivity, disturbance of the body's operating sequences produces an artificial rhythmicity, often a rocking movement that provides the captive animal with a substitute framework within which it becomes spatially and temporally integrated. In the human, similar phenomena of exteriorized rhythmicity are observed in circumstances where the creation of an artificial framework assists the individual to free him or herself from the normal operating cycle or to engage in a process of intellectual assimilation. There are many examples of this: Chinese schoolchildren rock backward and forward when reciting lists of characters, French ones do likewise with their multiplication tables. The fingering of "worry beads" in the Eastern Mediterranean area is a similar phenomenon. In many cases the trance-like state is maintained by a motion confined to just one part of the body, such as twisting one's thumbs or kneading some plastic substance or rolling a spherical object between the fingers. Obviously such rhythmic practices are rarely a matter of muscular play alone; rather, they form part of a whole in which hearing often plays an important role, as when the Buddhist monk chants while rhythmically striking a gong.

Beyond this point the role of the osteomuscular infrastructure tends to be disguised by the quality of the superstructure. Integration in exceptional sequences through rhythmic treading, whirling, choreography, prostrations, or genuflections performed at set times, and walking in procession is found in both religious and profane events and in all parts of the world. Accompanied by music, unlike the actions described in the preceding paragraph, they assume the character of a real escape from the environment of everyday life. This category of actions always has a dematerializing value. From the military march past to the possession trance, the degree of muscular alienation is total.

Society's hold on the individual through rhythmic conditioning is reflected in certain collective attitudes which are highly characteristic. "Bringing to heel," in French "*mettre au pas*," literally "bringing into step," is not just a military image. Rhythmic uniformization, the reduction of individuals to a conditioned crowd, is quite as marked in subway cars as it is at a funeral, in dervish exercises as in the sudden rush of schoolchildren when the bell rings for break. The science of muscular conditioning has been practiced empirically for purposes of political uniformization since the dawn of the earliest cities. It forms the basis for today's crowd movements, for the behavior of masses "marching as one being."

The same phenomenon is observed in architectural functionalism, which tends to order—and therefore to organize rhythmically—the movements of people in the environment of their work or their home. The introduction of music on the factory floor can also be viewed as an attempt at muscular conditioning; "music while you work" represents a complete mutation of operating behavior, a technique normally used to lift people out of their ordinary environment being applied in order to make them work more efficiently inside that environment. A distinction needs to be drawn between the conscious performance of complex operational sequences against a background of sounds rhythmically unconnected with the work being done and the process of complete integration achieved by performing stereotyped sequences against a musical background rhythmically integrated in the work. The latter form is met with in the most diverse societies in connection with collective tasks of all kinds, such as plowing, hoeing, threshing, or hauling. As with industrial manufacture the object is to *dis*integrate a certain number of individuals in order to *re*integrate them into a collective tool. The rhythmic productivity-raising methods employed in industrial societies owe their inhuman quality to the remoteness of the entities for which the individuals are working and the fact that, once the work is done, these individuals will disperse, whereas in traditional societies the technical operation, performed for a visible and known beneficiary, is only a phase in a collective process with all the manifestations of group cohesion.

In the next chapters, the "beautiful," the "good," and the "better" will take on an increasingly intellectual value. We may end up forgetting that even when, lying down and surrounded by complete silence, we read a poem, whatever image is conjured up by the words we read is significant only to the extent that it refers to everything we have experienced in the past in concrete situations comparable enough to the poetic image to make it intellectually graspable. Yet the first reference of all concrete experience is to the body, or rather, all experience relates to time and space as perceived by the body. It is essential to keep this idea in mind when judging aesthetic or intellectual performances or products at a high level. Seen by animals or by organisms fundamentally different from ourselves, we would appear to be obsessed by time and space. Ever since the emergence of civilization these concerns have dominated all our areas of thought. The fabric of our practical life is woven of the material conquest of geographical and—eventually, cosmic space—the compression of time through speed and the efforts of medical research. Speculation about astronomy and light, metrology and the physics of the atom, beguiles our philosophical and scientific dreams. Our spiritual dreams feed upon the conquest of eternity and the celestial spheres. For thousands of years our favorite game has been to organize time and space in rhythms, in the calendar, in architecture. Our microcosmic creations support the religious apparatus in which the fate of the universe is settled. Even negatively, time and space weigh upon every one of our gestures, and if we withdraw into the desert seeking immobility and contemplation, we do so to escape from "the age," that is to say, from both the time and the space in which the rhythms of normal life are taking place. The lives of the great spatiotemporal escape artists fill the Taoist with admiration, as they do the Buddhist and the Christian. The reason why human thought is thus invaded by perception of the fugitive nature of time and motion is the perfectly banal one that life on earth is situated at the intersection of time and space. To observe that we are acutely conscious of this fact is to discover nothing at all. Yet discovery there was, once: The image of time and space was new when the human first realized that he could relive them both by saying "he was by the river," "he is at my house," "he will be in the forest tomorrow." For the rest of the living world, time and space have no initial reference other than that of the bowels, the labyrinth of the ear, and the muscles. Hunger, balance, and motion are the tripod upon which rest the higher reference senses of touch, smell, hearing, and sight. All this is also true of us—but with the addition of our enormously complex symbol-making machinery, which underlies the whole of the Cartesian perspective.

Taste

Taste is the lowliest of the human senses, as it is of all animals. The role of the papillae distributed at the entrance to the digestive tract is essentially defensive: They are nociceptive; they send out alarm signals on contact with acids or salts capable of producing a toxic effect. Their intervention is general in both invertebrates and vertebrates, and they always line the buccal orifice. The register of perceptions is fairly narrow. Most animals, like us, can distinguish more or less clearly between sour, salt, sweet, and bitter tastes. To these one might also add pungency, which, however, is less a matter of taste than of direct assault upon the mucous membranes.

Taste does not operate as a space reference in animals with the exception of fish, where it is associated with the sense of smell. In some insects to which the search for sweet food is of extreme importance, the presence of taste buds on the tarsus of the front legs provides something like a spatial reference, and the same is no doubt true of ant-eating or termite-eating mammals, whose very long and narrow tongue acts as a feeler. In this case, however, the sense of touch certainly predominates.

Gastronomy

The aesthetics of gastronomy are based on a very general biological fact, namely the ability to recognize different foods. Animals all along the scale can absorb a certain range of foods which they recognize not only through their organs of taste but also by association with mutually complementary sensory images. The senses (not including the sense of hearing) intervene in their relative order as spatial references: Birds, in which visual reference predominates, recognize principally by sight and secondarily by touch and by smell and touch combined; fish, whose spatial references are largely conditioned by smell and taste, recognize their food in the simplest way. The vertebrates' scale of conditioned food acceptance sequences is based on sight and smell for purposes of recognition from a distance and feel in the mouth plus a combination of smell and taste for immediate recognition, memory playing a strong role in orienting preference and rejection. In mammals, acquired preference plays a significant if not a predominant role in carnivores and omnivores because of the long period during which the young of these species depend upon their parents for dietary education. The adult animal is in some measure capable of extending its range of foods, but generally speaking preferences in later life are guided by childhood tastes.

The food aesthetics of human beings are not very different. They are determined by sight and smell as well as by taste and feel in the mouth, and preference sequences formed in early life often guide the tastes of the adult. Everything that is edible can be used in the extraordinarily accommodating digestive tract of the human species, but far from everything is actually eaten. Unless forced by famine, human groups will reject many kinds of food and will show preferences strongly marked by ethnic personality. Yet again, the social organism takes the place of the zoological species in determining the mechanical sequences that mold individual taste. The subdivisions of humankind can be mapped by regional cuisine—not in terms of the worldwide distribution of animals and edible plants but as a function of gastronomical preference systems based on both local and imported foods. Sensory reference systems develop in the same way as gestures, speech, and music, and they lend themselves to aesthetic analysis because, being human, they include the feedback effect of reflection.

Food preferences acquired through ethnic education are like all human systems of tradition in that they are channeled through a code whose general rules form the basis of the tastes of the community at large and whose detailed interpretation is up to the individual.

The reference system of French cooking, for example, relatively complex though it is, can be reduced to a general framework within which the tastes of practically all individuals are accommodated. The range of strictly gustatory effects is rather rigid, some dishes being savory, others sweet, and a few sour. The code goes so far as to prescribe the order in which these gustatory effects must succeed each other: discreetly acidified hors d'oeuvre, savory main dish, acid salad, savory cheese, sweet pudding. Salt and sour go together, the pungency of pepper or mustard is added up to the cheese course; in the classic tradition, sweet and savory must avoid one another. Thus certain taste associations are considered to be harmonious, but this is entirely a matter of ethnic convention, for certain regions of France and some other countries do combine savory and sweet in their main dishes, marry sweet with sour, and slip bitter-tasting substances among their condiments. In African societies the use of potassic ash in place of salt creates a gustatory register of a special kind.

It is interesting to observe the aesthetic ordering of what is the simplest of our sensory systems, our taste buds, which in biological terms are mere alarm signals designed to prevent the ingestion of dangerous substances or to recognize certain simple foods such as salt and sugar. Primitive peoples who consume a great deal of fruit generally appreciate sour and sweet-tasting food. Appreciation of savory foods is rarer, for Australian aborigines, Eskimos, and Bushmen do not have direct knowledge of salt except for seawater and seaweed in the case of Eskimos. The limited and relatively constant nature of strictly gustatory perceptions explains the role they assume in cultures with developed gastronomical aesthetics. They are like the keynote in music: They strike the prevailing note and provide a basso continuo against which other values enter into play.

These other values are distributed between the senses of buccal touch and of smell. The sense of touch in gastronomy is determined by temperature and consistency. In very highly developed cuisines, the role of temperature parallels that of basic taste: A well-balanced meal will display a full range of temperatures from piping-hot soup to iced sherbet by way of cold hors d'oeuvres and a hot main dish. The same is true of consistency, with soft and firm, sticky and crisp, chewy, juicy, grainy, and smooth making a counterpoint with the basic savors and the temperatures.

Gustatory sensibility and feel in the mouth thus account for the deeper part of culinary aesthetics, upon which the embellishments of olfactory gastronomy are superimposed. This part—the primitive basis of gastronomy—is known even in the least sophisticated dietary practices through simple associations of olfactory perceptions obtained without the use of condiments.

Olfactory and Visual Gastronomy

The superstructure of gastronomical aesthetics is essentially olfactory. The spatial location apparatus constituted by our organs of smell is capable of infinitely more subtle performance than the reference organs of the mouth. It forms part of a reference system no less rich than sight or hearing, and has to be included under physiological aesthetics only because of the biological factors that separate it from speech.

In the animal world olfactory identification may rank higher than sight or hearing. This is the case with many mammals. Where it is the chief sense of reference, for instance, as in dogs, it forms the bulk of what may be termed the animal's intellectual capital. We cannot clearly visualize what an image of the world based on the senses of smell might be; in the spatial images of primates and anthropoids, it plays a purely secondary role. Among the human reference senses its place is rather special. Sight and hearing—which, like the hand, are involved in language—are the only senses to form part of the emitting and receiving system through which figurative symbols are exchanged. The sense of smell, being purely receptive, has no complementary organ for the emission of symbols of odors. It thus remains outside the most essentially human mechanism. Although reflection can codify its perceptions, they are nontransmissible. That is why gastronomy and olfactory aesthetics in general do not fall within the category of the fine arts.

Still some of the deepest cultural reference systems of ethnic personality have been based on the identifying perception present in all dietary operations, and the links between cuisine and ethnic personality are almost entirely olfactory. There are many national cuisines in which rice is the staple element, but no one can confuse a Malagasy rice dish with an Indian, Chinese, Hungarian, or Spanish one, for the simple reason that culinary processing entails the creation of a bouquet of smells and tastes peculiar to each culture.

The use of condiments is a somewhat special area of culinary art in that, unlike all others, it is entirely without spatial or temporal references. The shape of an implement has a certain movement as its corollary; so does a statuette, and the same is true of a form of social politeness, a building, a poem, or a hymn. The use of thyme in combination with salt and nutmeg is not translatable into movements or even into words. Culinary art does not share that characteristic trait of all other arts which is the possibility of figurative representation; it never reaches the symbolic level. Everything is symbolizable in theory, but in gastronomy too much substitution would be required. You can use a meal as a symbol for the workings of the world at large, but then you are talking about the rhythm at which the courses are served and the meaning of each separate dish apart from its purely gastronomical characteristics. The smell of thyme may symbolize a Mediterranean hillside at daybreak, but that is due to the little that the human sense of smell still has to do with spatiotemporal reference. A dish may be a picture, but then it enters the field of visual reference, and how it looks does not represent how it tastes.

In gastronomy whatever has to do with something other than the aesthetic development of dietary recognition is no longer gastronomical. In theory the real basis of this aesthetic-without-a-language is formed of taste, smell, and consistency. However, the sense of sight in humans is too important to be excluded. In its spatiotemporal reference role sight of course is only secondary: A dish may look terrible but still be very good, which is impossible in the figurative arts and which clearly demonstrates the separateness, in gastronomy, of the basic aesthetics of nutrition from the aesthetics of space and time. The role of sight as a means of food recognition is far more important. In the human, a mammal whose sense of smell is poor, food is recognized above all by sight, so that if a meal is, say, served in a violet light our sense of smell cannot be relied upon and the actual ingestion of the meal, with all the visceral activity it involves, will be disturbed. The phenomenon here is entirely different from what happens if, say, a caramel sponge cake is served in the shape of a chicken: The effect then is similar to trompe l'oeil in painting; an immediate transposition will take place without the food being any the less acceptable. An additional esthetic effect has been created, but the normal harmonies remain intact.

The Sense of Smell

Food recognition apart, our sense of smell fulfills, to varying degrees, the twin functions of identification and spatiotemporal integration. In technical activities, and especially in chemistry, whose processes are similar to cooking, it serves the former of those two purposes.

In affective behavior, which for the most part finds material expression in social aesthetics, the sense of smell still plays an important role in relations between individuals. Perfumes, aromatic oils, and deodorants, whether used to disguise the natural odors of the body or to create an idealized image, are a significant element of relations between the sexes. It is interesting to note that figurative representation is possible to some extent in this context. Between the civet cat or the dog marking out their territory and the human female's use of flower scents or of the contents of the civet cat's glands, the process of figurative representation has entered into play. Smell has become the symbol of a motor process whose references no longer derive from the digestive mechanism (which does not admit figurative representation) but from the muscular dynamic that forms the basis both for affective behavior and for spatial integration. Here the sense of smell stands at the threshold of the imaginary in the strict sense.

That threshold has been crossed when the sense of smell fulfills the function of spatiotemporal integration—in other words, when it serves for perceiving one's situation in time and space. The world of many animals is, above all, a world of smells. It is perfectly conceivable that a fund of knowledge should be based on analyzing smells: Instead of building their perception on sight and hearing, as humans do, dogs build theirs on smell and hearing, the function of sight being only to confirm the perceptions thus received. The gap between human thinking and animal thinking constructed in this way is obviously a wide one. Dogs can, within the limits of their muscular capability, learn deductive sequences, but any possibility of reflective behavior of the human kind is completely lacking. If we tried to invent a dog with a developed brain comparable to ours, we should have to provide it with a rhinencephalus of enormous size wherein the instruments for an extraordinarily fine perception of the world of smells would have developed side by side with a hyperaffectivity that would endow such a creature with a "sentimental" intelligence in place of our rational one. Let us not forget that what makes us human is precisely the duality of the facial and manual operating fields and the basic link between grasping and sight. In the dog the anterior field is located in the narrow space between the nostrils, which explore from a distance, and the canines, which seize; in the human sight serves an exploratory purpose and enables the hand to exercise functions, not only of grasping but also of complex construction. Whereas the dog's evolutive potentialities lay in the direction of areas common to the sense of smell and to affectivity, thus precluding figurative representation, human evolution toward dominant vision and manual motor function opened to us the universe of rational imagination. For us, the world of odor therefore serves as a secondary practical reference, though not a negligible one: Let a smell of smoke pervade a house, and the inhabitant will soon be sniffing the wind to get the spatial references. Aesthetically, the sense of smell is closely connected with the visual and auditory systems; a particular odor, unperceived for many years, will suddenly evoke scenes forgotten since childhood. We do not recollect odors as we do events, but olfactory perception, precisely because it activates physiological areas unrelated to reflection, bestows considerable depth and intensity upon reflective images.

For similar reasons odors can be a determining element in escaping from day-to-day sequences. They can induce a state of beatitude or promote overexcitement. Certain environments located outside the commonplace world of time and space have an olfactory ambience that isolates them from what is experienced normally. This is true of the incense used in holy places, the stench of holocausts, the smell of gunpowder intoxicating to the battleground hero. Their role is far greater than a mere condiment's; odors in such cases become the chief scene-setting element that releases extremely deep-rooted emotional reactions. We need only imagine a sanctuary pervaded by tempting kitchen smells, or spring breezes wafting suddenly across a battlefield, to realize how seriously this would impair our conditioning. I speak of "conditioning" advisedly, for when all is said and done, the sense of smell remains firmly embedded in the physiological. Piety in biblical times was not incompatible with the odor of roasting meat, and battles are sometimes fought in a flowering meadow. This brings out, on the one hand, the importance of acquired traditions and, on the other, the flexible nature of olfactory behavior as a reference of location. A dog would refuse to believe a piece of meat was a piece of meat if it smelled of freshly mowed hay, and a human would stop believing in a battle if the battlefield was suddenly filled with images associated with a village fete.

The Sense of Touch

The sense of touch of vertebrates, their source of direct reference in space, has the same topographical location. Tactile organs are very densely concentrated in the anterior facial zone and somewhat less so at the extremity of the forelimb; they are more sparsely scattered over the rest of the body. The lips are the seat of the subtlest sensitivity to temperatures, vibrations, and contact; their sensory equipment is often reinforced by palps, for example, as in fish, or by long stiff whiskers as in felines and rodents. The origin of the sense of touch lies close to that of hearing, and the two appear to combine in many animals, especially fish and mammals with a little or no sense of vision, such as the mole. Hearing and tactile perception in its broadest sense are extremely important in gregarious behavior; they are principally responsible for the movements of shoals of fish and of herds of animals in close formation.

In humans the organs of touch are distributed as they are in other vertebrates: The lips are responsive to a load of as little as 5 to 6 milligrams per 0.1 millimeter of their surface and the fingertips to a load of 30 to 40 milligrams, the sensibility of the rest of the body being variable but much less pronounced.

The importance of touch as a surface of spatial reference is particularly great where visual reference is lacking, that is, in the blind, in darkness, or outside the field of vision. Unlike the sense of smell, it appears to be extremely subtle under such conditions. Unlike the sense of sight, whose mode of perception is synthetic from the start, it can analyze and recreate volume by passing the hand and fingers over the object. This combination of motion and touch makes it one of the senses accessible to figurative perception.

Labial touch relates to feeding or affective behavior more than to types of behavior pertaining to figurative aesthetics. Body touch relates to comfort and physical integration in space. Only in the manual field is there an aesthetic that can properly be described as tactile. It stays very close to the physiological level and, in various ways, has to do with the sensation of caressing. It involves textures—such as those of polished materials, furs, and grains, the consistencies of plastic pastes, and the feel of flexible or elastic substances—and is exercised in techniques aimed at producing surfaces agreeable to the touch—such as sculpture. Tactile judgment is constantly exercised in day-to-day operations. Unlike smell, touch is practically never the source of extraordinary integration, at least not as the dominant perception. Rhythmic sounds and movements as well as unusual odors can trigger states of exteriorization from routine sequences, but conditioning by the sense of touch is hard to imagine. This is principally due to the analytical nature of tactile perception, which stands in the way of complete immersion in a situation.

There can be no doubt, however, that the sense of touch plays a part in that specific area where recurrent tactile movement determines a transposition of muscular behavior. All over the world repeated manipulations of small objects—handling of prayer beads in Christian, Muslim, or Buddhist cultures, rolling grains or pieces of jade between the fingers, prolonged kneading of a flexible substance—accompany states of meditation or peaceful reverie (see the discussion of muscular sensibility earlier in this chapter). Objects specially designed for purposes of tactile aesthetics exist only in this very narrow area where perception of form is focalized and beyond which the machine of the body is entirely at rest.

Spatiotemporal Integration

Our coverage of the subject of physiological aesthetics would be incomplete if we failed to mention the sense of hearing and sight, but only in so far as these still contain elements of infraverbal behavior. Whatever there is in human sensory equipment that is inherited from the common fund of species cannot be understood unless we go right back to the sources. In the case of the senses of taste, smell, and touch, as well as of visceral sensibility and muscular perception, human forms of perception and expression barely impinge upon the common zoological fund. One could pursue the ascent toward the "noble" senses and demonstrate that the spatial integration of the human individual at rest in his hut is not very different from that of the badger in his earth, or that our social recognition systems are remarkably similar to the codes that enable birds to establish relationships among themselves on the basis of their plumage. But between the living space of the badger and the space symbolically constructed by a human, between the plumage of the grouse and the army officer's symbolic uniform, between the song of the nightingale and a sentimental ditty, the borderline has already been crossed. Our lived behavior is filtered through images, and though we need to acknowledge the deep-seated origins of our behavior, it would be paradoxical and futile to pretend, for the sake of an excessive concern with logic, that they account for the whole of it. That is why, now that the concept of functional aesthetics as it relates to the properties of the human hand has been established, we shall revert to the senses of sight and hearing when discussing the question of bodily balance in the chapters devoted to social and figurative aesthetics.

12 Functional Aesthetics

An analysis of objects of practical use—tools, machines, engines, houses, or cities—shows that they possess particular aesthetic properties directly related to their function. In saying that a form is or is not well suited to its function, we make what amounts to an aesthetic judgment. It is a striking fact that except in some rare cases, if not always, absolute aesthetic value is directly proportional to the adequacy of form to function. Tracing the development of many technical objects over time, we observe their gradual integration in increasingly balanced forms. One need only think of aviation to measure the validity of this general law.

It has long been recognized that functional development is a law. Efforts to determine the modalities of that law, still empirical in most technical fields, have reached the stage of systematic research in some others. Our nautical and astronautical sciences, as well as aviation, are open to the pursuit of perfectly efficient forms. Curiously enough, the results of these efforts are often broadly comparable to forms derived from nature. This should perhaps alert us to the possibility that the two phenomena may in fact be the same—that the functional quality of human-made objects, rather than being figurative, may simply represent the inversion, in the human field, of an absolutely natural process.

Such a supposition is supported by the argument that an object achieves functional beauty to the extent that it is divested of its figurative content: The automobile, which took a very long time to rid itself of the figurative representation of the harnessed horse-carriage, has achieved relative functional adequacy only in so far as it meets the laws that govern a solid object traveling rapidly through space while remaining in contact with the ground. If we examine groups of objects having the same function but belonging to different cultures, or objects having different functions within the same culture, we recognize the nonfigurative nature of functional beauty. Whether we take shields, looms, hoes, fishhooks, or typewriters, we see their function, realized to a greater or lesser degree, piercing the decorative veil that shrouds the forms. Let us take, as functionally adequate objects, a Louis XIII armchair and an African ruler's throne with legs in the form of human beings: in both, the functional forms are apparent through the figurative envelope, whether the motifs—direct translations of language-related symbols—are anthropomorphic or based on plants. Take away the envelope and what is left is a functional formula, that of a seat which ensures a modicum of restfulness with a maximum of dignity. The dignity requirement is a consequence of the social aesthetics pertaining to high rank. Take this away from both seats, and you need only take a cast of the body of the person to be supported in a seated position in order to obtain a purely functional concave object, a seat in the form of a shell with judiciously oriented supports, its shape strongly reminiscent of a seashell's.

The appropriateness of natural forms is not, however, absolute. One would have to go back to the preevolutionist naturalists and Bernardin de Saint-Pierre to find the view that all plants or animals have the form exactly suitable for their biological integration. Paleontology shows that forms evolve toward functional solutions that even at the end of the process are only relatively successful. Function and form, both adrift in time, constantly interact. An equally striking fact is that at each stage the functional solution is concealed behind a "decorative" veil—colors, appendages, disconcerting curves—similar to that thrown around manufactured objects, as though also in the human the decorative function corresponded to a nonartificial balance. The relationship of function to form is actually of a different order from that of form to decoration. In animals as in humans, the nonfunctional envelope is a tissue of relics, vestiges of a phyletic origin that in the former is connected with the past of the species and in the latter with the past of the ethnic group. The fact that the decorative pattern on a butterfly's wing has mimetic value is of quite a different order from the wing's appropriateness for travel through air: The latter can be reduced to mechanical formulas and has the value of a physical law, whereas wing markings belong to the uncertain world of style even if, in Darwinian terms, they perform a protective function for a certain length of time in the history of the species. Human decoration only confirms the general rule of substitution of the ethnic group for the species; the same phenomena can be observed in the persistence of marks expressing the personality of a group.

This comparison makes the nature of functional aesthetics a little clearer. It seems to correspond to a real mechanical determinism, and to be subject to the laws of matter rather than those of the living world—which is why its nature is the same whether we consider plants, animals, or humans. The cells of the beehive are a perfect solution to the problem of the ratio between surface and volume that offers maximum resistance to deformation, but the same solution is also encountered in vegetable tissue and applied in human industry. Once the formula of hexagonal cells has been found, there is no room left for species-related or ethnic nuances; aesthetic value lies wholly in the absolute mechanical perfection of the design.

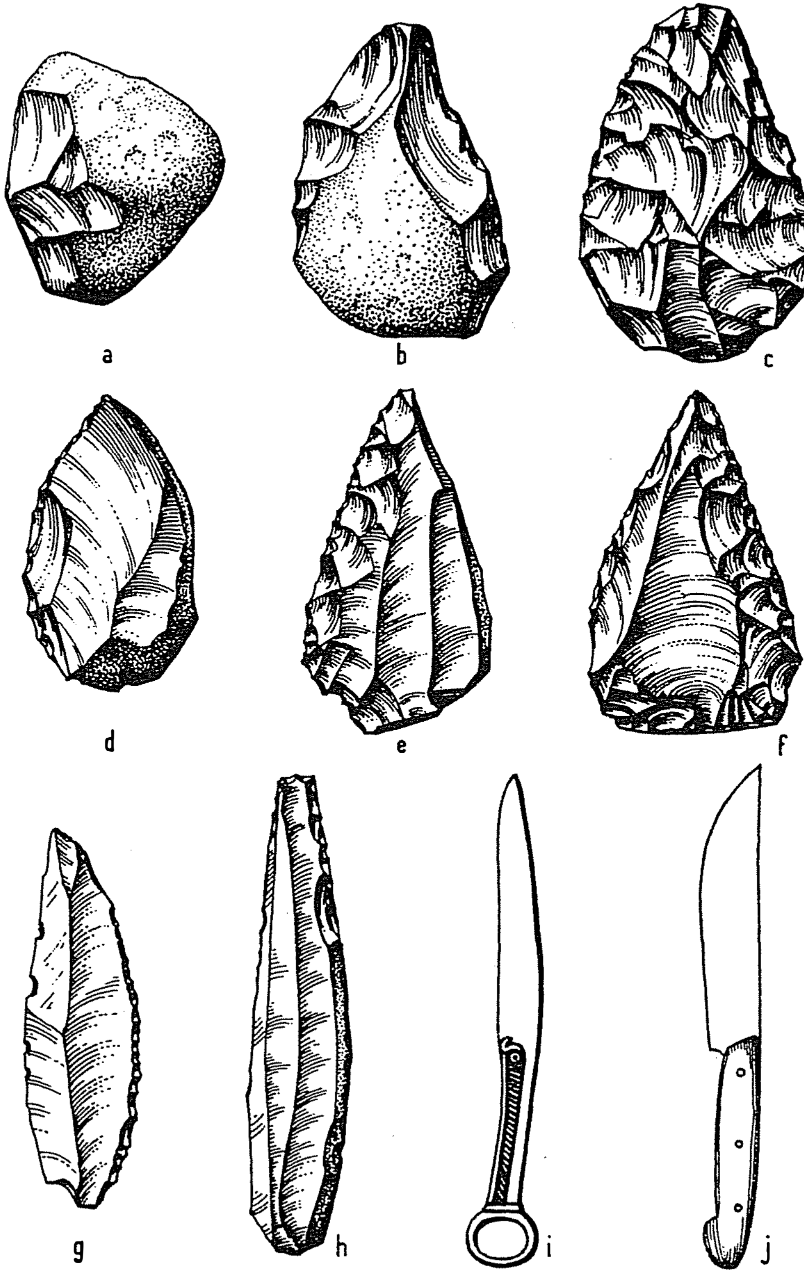
In the living world, including the human one, perfect functional solutions are rarely achieved because above a certain level life implies a multiplicity of functions; functional appropriateness is reserved for organisms and objects with a single function. From the point of view of mechanics, the mackerel is undoubtedly more satisfactory than the monkey: Its hydrodynamics are almost ideally suited to traveling rapidly and performing instantaneous movements, travel, which is its way of finding as well as capturing food, is its only function involving responsiveness to the outside world. Or take the awl, a mechanically perfect tool; whether made of bone or of steel, its cylindroconical shape has, since the end of the Mousterian period, offered a perfect means of piercing flexible materials. The awl is incomparably closer to a perfect functional formula than a Swiss army knife with its scissors, corkscrew, saw, file, three knives, and tool for taking stones out of horses' hooves. The monkey and, at least as much if not more so, the human being are much more like the Swiss army knife than like the awl. Most living beings and objects are balanced in a complex interplay between (1) the evolution of each function toward satisfactory forms, (2) a compromise between various functions whereby the forms are maintained at a more or less high level of approximation, and (3) superstructures inherited from the biological or ethnic past, which are reflected in "decorative" elements. Therefore in the majority of cases functional aesthetic analysis is simply a matter of measuring the degree of functional approximation.

One could, it is true, go a little further and say that the measure of aesthetic value is the extent to which the mechanical formulas remain valid beneath the veil of the overlying figurative values. To go back to the example of the armchair, a chair can never achieve perfection in terms of strict functionality, for to do so, it would have to be designed for just one individual sitting in just one position. A degree of functional plasticity will always be present, and so will an element of style, so that the most coldly calculated of today's armchairs is recognizable as an American, Finnish, or Japanese product of the midtwentieth century. The same is true of automobile design, where the aerodynamic element is only a very approximate trend while the general style and the decorative features employed show great ethnic diversity.

An attempt to analyze functional characteristics separately is therefore justified, even though a complete separation is almost always impossible to achieve. However, in conducting our functional analysis we can, for the sake of convenience, separate the evolution of function from that of form, materials, and rhythms. An ax is appropriate to a certain swinging linear percussive function by its form, by the stone, bronze, or steel of its blade and by the rhythmic movement, determined by the user's relative weight and muscular strength, that actuates it. Its functional evolution should therefore be analyzed at four levels simultaneously, which is impossible because of the linearity of rational thought and of language. Even without this obstacle, it could be argued that a swinging linear percussive function is also to be found in the machete, that the form of the ax is influenced by the same mechanical trends as other swung tools such as the adze, the hoe, the hammer, or the club, that the transition from flint to steel was a phenomenon that affected many things outside the category of swung percussive tools, and that the rhythm of the ax is very much the same as that of the scythe or the grain pounder.

Function and Form

In *L'Homme et la matière* I related the function of tools to what I described as a technical "trend," a process that makes it possible, at the purely technological level, to observe the gradual acquisition of distinct forms. In paleontology as well as in history, the evidence of different stages traversed by the same functional trend enables us to observe not only the specialization of forms but actual mutations, the function persisting and becoming more pronounced through the emergence of new forms. The function still represented in our society by the knife in the action of cutting any object is a remarkable example, for the paleontology of the knife goes back without a break to the earliest tools (figure 108). From the awkward, irregular small cutting edge of the Australanthropian chopper it developed into the blade of the heavy biface and that of the scraper. At the beginning of the Upper Paleolithic, the oval scraper was replaced by fine cutting blades, and the knife assumed a form that remained essentially unchanged until the emergence of metals. Its proportions have remained the same since the Bronze Age, which saw the completion of its functional evolution into a blade with a handle of which its blunt edge was the extension. But then the function, which had already gone through four or five successive forms, passed to machines in which rotary blades or mechanical slicers converted rectilinear into circular motion. Many other tools, such as the series that began with the flint burin for carving bone or wood and today includes the adze, the carpenter's chisel, and the router, underwent a similar evolution. Mechanical engines provide another striking example; without going back as far as the transition from weight-driven to



108. Evolution of the knife. Lower Paleolithic: (a) *chopper,* (b) *rudimentary biface,* (c) *Acheulian biface. Middle Paleolithic (about 100,000* B.C.*):* (d) *and* (e) *scrapers,* (f) *Levalloisian point. Upper Paleolithic (35,000–10,000* B.C.*):* (g) *Châtelperronian point,* (h) *Magdalenian blade. Bronze Age (1000* B.C.*):* (i) *knife (Siberia). Iron Age:* (j) *modern knife (Greece).*

spring-driven mechanisms, we need only consider the progression, between the late eighteenth century and the present day, from the early piston and shaft engines through the crank and piston engine of the first locomotives to the crankshaft-coordinated pistons of the automobile engine, the turbine engines and the jet plane, to grasp the importance of a phenomenon in which the relationship between function and form appears in a different yet complementary light.

Here the function appears even more clearly as a simple physical formula, abstract and lacking any base in aesthetics other than the underlying elegance of its equations. The aesthetic "moment" is situated along the trajectory of each form at the point where the form comes closest to the formula; the aesthetic quality of the conjunction of function and form is equally apparent in a highly developed biface, a well-made scraper, and a bronze knife particularly well suited to its purpose.

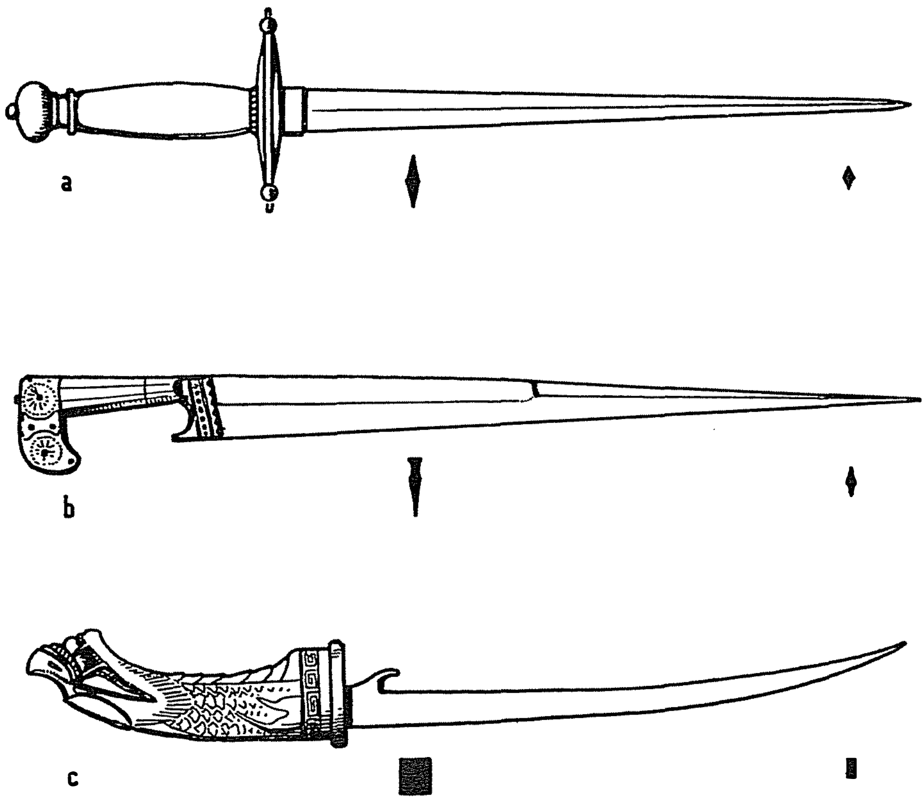
The principles of functional aesthetics are derived from the laws governing matter and cannot, by that token, be regarded as human attributes except to a very limited extent. The principle that perfect forms correspond to simple functions applies as much to birds such as the albatross, whose wings tend to be no more than flying-sails, as to a type of lance designed simply to pierce. There is a tendency today to regard such forms as highly aesthetic because mathematics and physics count for so much in our civilization, but most previous cultures considered perfect forms as being aesthetically poor. The blade of the Japanese sword is a miracle of functional balance, yet the armouries of China, India, and Indonesia teem with elaborate blade forms designed to impress and terrify. In most cases perfect forms are modest and, because of their commonplace nature, do not capture the ethnic imagination.

There is probably a good reason for this: The reduction of forms to bare formulas would have run contrary to well-balanced diversification of species as well as of ethnic groups. Present-day efforts to prevent forms from becoming completely desiccated as a result of excessive perfection are significant in this respect.

What we have said seems to suggest that the origin of form lies in the pursuit of ideal function; at the same time, however, we have seen that approximation to functional perfection is the rule in all but exceptional cases. The reasons for this are to be found in two opposing trends. The former lies outside aesthetics and pertains to the "favorable environment" theory (see *Milieu et techniques*): Neither the material (flint) nor the technique (scraping) available to Mousterian man enabled him to make a perfect knife; nor can we today make the perfect artificial brain, which would probably be small in volume and relatively simple. Efficient forms are therefore subject to diversity in time and space which is related to the stage of development of the technique concerned.

The second trend is more strictly an aesthetic one in that it involves a certain freedom in the interpretation of the relationship between form and function. If, for example, we consider a series of Saharan flint arrowheads, we are struck by the extraordinary wealth of variations on the same functional formula: variations in the relationship between length and width, the angular width of the body, and subtle differences in the convexity or concavity of the blades. Beneath the constraints imposed by the material one senses the individual arrowhead maker's personal way of handling an empirically perceived functional outline.

The same function may, in different cultures, assume equivalent forms, which, however, will be strongly marked by the personality of the ethnic group. One of the most striking examples is that of the *dagger*, specially designed to pierce coats of mail or penetrate through chinks in armor (figure 109). To meet this purpose, the weapon



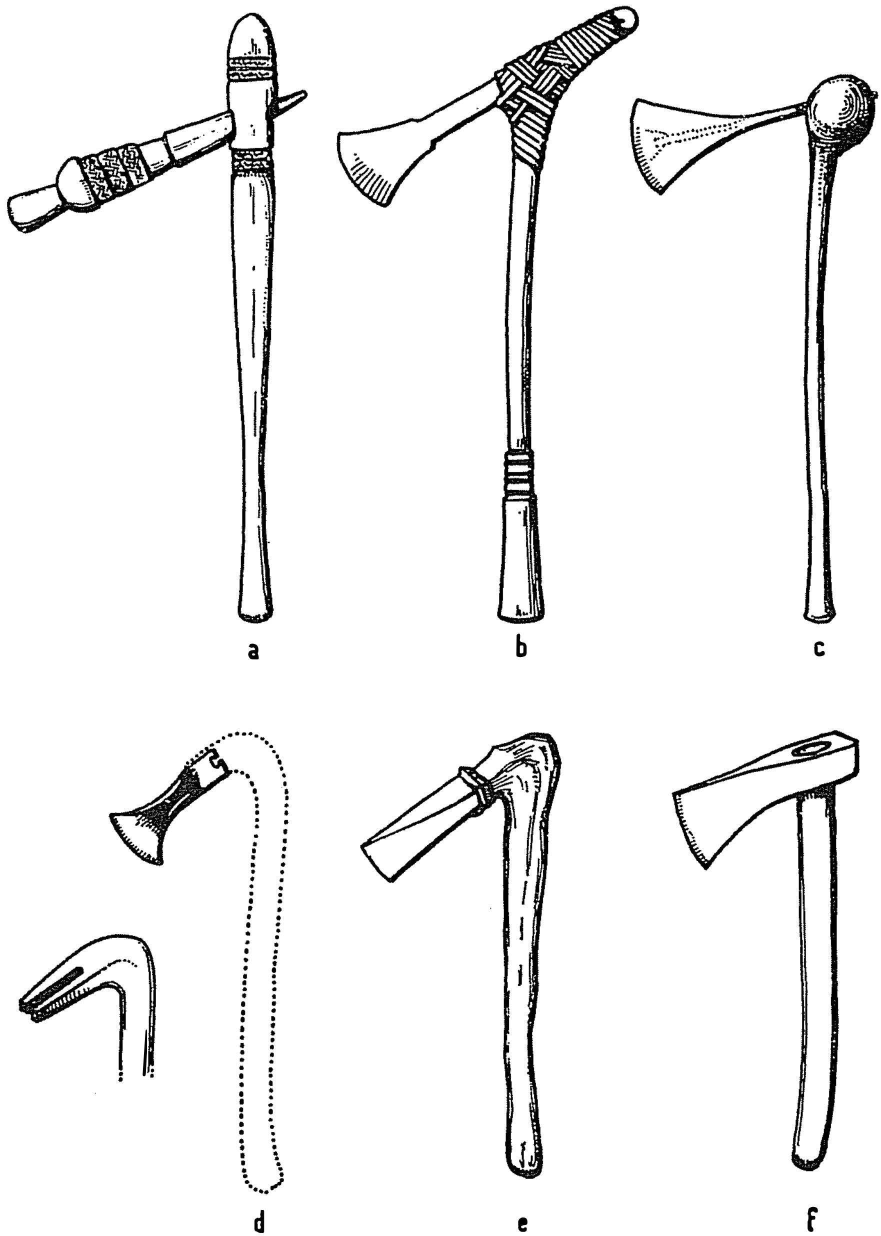
109. Daggers: (a) European type based on the sword, (b) Iranian type based on the knife, (c) Japanese type based on the saber.

must have a blade 30 to 40 centimeters long with a very pointed tip of square or lozenge-shaped cross section. This functional ideal was reached between the fourteenth and eighteenth centuries in Europe, the Near East, and Japan. The daggers of the three great civilizations have practically identical properties in the quality of the steel and the depth of penetration of the blade tips, but the European one takes the form of a short double-bladed rapier, the Near Eastern one that of a straight knife, and the Japanese one that of a short curved saber. It would of course be possible to demonstrate that none of the three completely meets the theoretical ideal in the depth of penetration, and we are obliged to resort to the concept of "functional approximation" in order to describe a response to the contradictory demands of mechanical appropriateness and the traditional aesthetics of the group. Similarly we could say that English, Italian, and American racing cars are in a state of functional approximation in that they preserve an ethnic style despite the requirements of aerodynamics that should, strictly speaking, make them all identical. American and Russian rockets and satellites too have elements that strikingly reflect their respective cultures despite the very close functional constraints of their design.

These examples illustrate the extent to which functional and figurative aesthetics interpenetrate in the objects produced by different cultures. Due allowance being made for the respective technical level, the ideal function is often very close to being achieved in many objects that nevertheless retain an unmistakable style in the narrow margin that function leaves to form.

Form and Material

The making of anything is a dialogue between the maker and the material employed. This opens up another margin for functional approximation. The example of the ax or the adze, whose history extends over some eight thousand years, brings out the functional relationship between form and material with particular clarity (figure 110). The polished stone ax and the steel ax correspond to the same ideal formula, that of a short rectilinear cutting edge supported longitudinally by a shaft capable of imparting considerable acceleration and by a head heavy enough to enable the edge to cut into wood. This ideal seems to have been attained right from the start, for the Neolithic axes known to us are already perfect in terms of the length of the haft, the weight of the head, and the angle of the cutting edge. Many problems arose, however, in connection with ensuring the effective orientation of a polished stone edge, preventing the shaft and the head from coming apart, and achieving sufficiently deep penetration without the blade becoming wedged in the wood, since



110. Functional adaptation of the ax. (a) New Guinea, stone blade sheathed in wood; (b) Borneo, hammered iron blade tied to the handle; (c) Rhodesia, hafted iron blade; (d) Bronze Age, bronze blade with pinion to prevent loosening of the haft; (e) Bronze Age, blade with socket; (f) modern, haft with forged collar.

to provide such a blade with a slit for the haft would be to rob it of its solidity. Other problems arose in the Bronze Age and found solutions in line with the technique of bronze casting. The advent of ferrous metallurgy, which meant that the blade was no longer cast but forged, brought fresh problems. The problem of function, although resolved from the outset, assumed a series of forms dictated by the raw materials successively employed. This was not a matter of slowly seeking the means to satisfy a functional requirement: Before the ax, trees were probably felled by fire and with the scraping tool, and today, now that the age of the ax is past, they are felled with a mechanical chain saw, which proves that the "ax" solution represents a homogeneous stage. Neither was it a case of considerations of form interfering with mechanical functionality, for axes of the same type are found, immediately recognizable by their style, in the European Neolithic, in Indian America, and in present-day Oceania, which proves that the form of a tool is governed by the interplay of three values: the ideal mechanical function, the material solutions to the problem of functional approximation, which is a matter of the state of technical development, and the style, which is a matter of ethnic figurative value.

This triple aspect of the aesthetics of products of human industry is to be found in all areas of technology, but in varying proportions that accentuate the ambivalent nature of functionality. In some cases, as with the awl, the form is established from the outset, and the slow progression of form through increasingly efficient materials is the only development that takes place. In other cases, as with pottery, the material presents no obstacle to the function, and the development takes place mainly between pure function and style. Although analysis is more difficult in the case of multifunctional assemblies, such as cities. The respective share of the theoretical formula and those of functional approximation and figurative symbolization can be identified fairly readily in the ground plan, the proportions of the buildings, the nature of the city walls, and the district layout, be it of a Mayan city, a Mesopotamian city, a medieval European town, or a city of today. As we shall see further on, a city is both an instrument subject to powerful material constraints and a symbolic image of the universe.

A separation of any other than a purely theoretical nature between form and material is difficult to uphold, both at the functional and at the figurative level, simply because rational forms as well as those regarded as beautiful are often based on the same physical formulas. In pottery a spherical form subtly modified toward the mouth or the base meets simultaneously the requirements of function and of taste. The slightly imperfect symmetry of a developed biface is mechanically justified, but it determines an aesthetic appreciation. Spherical or flat forms, symmetrical design or a curved surface, are rational in terms of function and, at the same time, attractive in a manner that goes beyond functionality. This aesthetic ambiguity is used to advantage in certain modern works of art, such as the machines of Alberto Giacometti or Jean Tinguely, which are mechanical assemblages without any rational function.

The material itself can be connected with function without being directly related to form; this is the case with objects designed to contain or enfold. The surface of a pottery vessel, depending on whether it is a huge receptacle for grain, a water jug, or a waterproof container, will be coarse, porous, or smooth; these surface states will be directly functional, with references borrowed from physiological aesthetics. The same is true of bark, skins, furs, textiles, or modern plastics, whose visual and tactile properties are determined by the link between function and the material employed.

Functional, physiological, and figurative aesthetics form what may be described as a cycle in those products of human industry that are not purely figurative. The predominant element of the cycle depends on the category to which the product belongs, but normally all three elements are present, if only in vestigial form, each making for deeper aesthetic perception.

Rhythms

Rhythms are the creators of space and time, at least for the individual. Space and time do not enter lived experience until they are materialized within a rhythmic frame. Rhythms are also the creators of forms. What we have already said about muscular rhythmicity applies a priori to technical operations that entail the repetition of gestures at regular intervals. A very large number of such gestures are related to the act of hammering, which occurs in birds—those that use their beaks to break molluscs or seeds as well as those that find their food in the bark of trees—but is exceptional in mammals, including even the great apes. One of the operating techniques of human beings from the earliest stages has been the application of rhythmic percussive movements repeated over prolonged periods. Indeed that is the only operation that marked the attainment of human status by the Australanthropians, whose only surviving traces are choppers made from splintered pebbles and polyhedral spherical objects produced by prolonged hammering. Manufacturing techniques developed from the beginning in a rhythmic setting—at once muscular, visual, and auditive—born of the repetition of impact-making gestures. The motion of sawing undoubtedly goes back to the same period, the purpose of hammering a pebble being to provide it with a cutting edge, and that of scraping is probably not much more recent. Hammering calls for swinging percussive movements, and sawing or scraping for oblique attack (see *L'Homme et la matière*), which in all cultures down to the present day have formed an essential part of technics.

In the human the treading motion that constitutes the rhythmic framework of walking is accompanied by rhythmic movements of the arm; whereas the former governs spatiotemporal integration and is the source of animation in the social sphere, the latter has to do with the individual's integration in what is not a time-and-space-creating but a form-creating system. The rhythmicity of walking led eventually to the kilometer and the hour, while manual rhythmicity led to the capture and immobilization of volumes, a purely human construct. The distance between musical rhythm, which is wholly a matter of time and measure, and the rhythm of the hammer or the hoe, which is a matter of immediate or deferred procreation of forms, is considerable. Musical rhythm generates behavior that symbolically marks the frontier between the natural world and humanized space, while technical rhythm materially transforms untamed nature into instruments of humanization. The two are strictly complementary, but as we have seen in the chapter dealing with the ascent of Prometheus (chapter 5), their position on the scale of values is not the same. Music, dance, theater, lived and mimed social situations, belong to the imagination—to the projection upon reality of a light that humanizes the zoological processes of human situations. They are the clothing in which we dress our social and interpersonal behavior obeying the most general biological rules; they are the intimate property of language as opposed to manual technicity. Technical rhythm has no imagination, it does not humanize behavior but only raw matter. Thousands of years ago figurative rhythms brought the Moon and Venus within the confines of a human-controlled world and turned them into reassuring actors upon a vast stage where humans made and unmade their gods; but technical rhythms are only just beginning laboriously to penetrate sidereal space. Yet the slow invasion of technology has little by little placed the imagination in a new situation. The gradual erosion of mythological thought (chapter 6) has set societies upon the course of "art for art's sake" which disguises the crisis in figurative representation. Individuals today are imbued with and conditioned by a rhythmicity that has reached a stage of almost total mechanicity (as opposed to humanization). The crisis of figuralism is the corollary of the dominance of machinism. In the next chapters we shall consider some approaches to the problem of the survival of demystified time and space. It is striking to observe that the greatest efforts to save figuralism through the transposition of mythological values—historical painting, the cult of heroes of labor, the deification of the machine—are being made in societies where the metaphysical dimension has been banished from the values of science and work. A balance as constant as the one that from the earliest times has coordinated the respective roles of figurative representation and technical activity cannot, it seems, be disturbed without putting in jeopardy the very sense of the human adventure.

13 The Symbols of Society

Technical gesture is the producer of forms, deriving them from inert nature and preparing them for animation. The arrow exists only in archery or in the images of movement it conjures up; the marketplace is transformed from being an empty space to the extent that it provides the nodal point from which the threads of its universal social integration radiate. Human beings are only human to the extent that they are in the midst of others and clothed in symbols that give purpose to their existence. Naked and immobile, the high priest and the vagabond are no longer the vehicles of a symbolically human system but mere bodies of higher mammals set in a time and a space without significance. The medieval dances of death were a profound reflection of the contrast between biological reality, in which the spiritual and the zoological are merged, and the symbolic apparatus of our social life. The life of animals is the progression of the individual genetic species; the life of human groups can substitute the ethnic for the genetic order only by erecting a time, space, and society that are wholly symbolic, interposed like the coastline of an island between the stability required and the anarchic movement of the natural world.

The Domestication of Time and Space

The human act *par excellence* is perhaps not so much the creation of tools as the domestication of time and space, or, to put it differently, the creation of a human time and space. Tools and language are the attributes of a new zoological group whose earliest representative known to us was the Australanthrope. The long ascent to the *sapiens* stage was yet to be made. A little before it was completed, the first traces of graphic symbolism became perceptible in the last Palaeoanthropians. Between the final Mousterian and Châtelperronian periods, 50,000 to 30,000 B.C., the first dwellings and the first engraved signs—simple alignments of parallel strokes—made their appearance simultaneously.

There is little doubt that the building of shelters dates back to a much earlier time, but the fact that the earliest maintained dwellings coincide with the appearance of the first rhythmic representations is singular. Integration within concrete time and space is common to all living beings, as we already pointed out in connection with physiological aesthetics. In animals, this integration expresses itself in different ways, and particularly in the perception of safety through the individual's inclusion in the space and rhythm of the herd, through reactions within the safety perimeter, or through the use of a temporary or permanent enclosed shelter such as a nest or a burrow. Our moral and physical comfort too is based on our wholly animal perception of the safety perimeter, the enclosed shelter, or socializing rhythms; it would be pointless to look once again for a division between animal and human in order to explain our own feelings of attachment to the rhythms of social life and to our inhabited space. Just as the hand is present in the ape without there being any question of technicity in the human sense, just as vocal signs are present at a level where there can be no question of language, so spatiotemporal perception exists at the bottom end of the scale and runs continuously through all the stages of humanization. In chapters 3 and 6 we have seen how, parallel to the development of tools evidenced by the remains of fossil industries, it is possible to calculate the rate at which language evolved among the vanished Anthropians. It should, on the face of it, be easier to detect traces of the transition from natural to constructed space in the soil than to do the same for language, but actually the stages are more difficult to elucidate. This is so in the first place because, unlike tools and language, the making of shelters is common to humans and many animals. A second reason is the inadequacy of archaeological sources: Well-preserved habitats before the appearance of *Homo sapiens* are rare, and few of them have so far been researched with sufficient precision to yield very detailed fossil records. The little we do know is, however, enough to show that a profound change took place at a moment which coincided with the development of the cerebral apparatus of forms close to *Homo sapiens* and also with the development of abstract symbolism, as well as with the intensive diversification of ethnic units (figures 111 to 113). These archaeological observations enable us to identify the phenomena of spatiotemporal insertion, from the Upper Paleolithic onward, with the symbolic apparatus of which language is the main instrument. They correspond to a real taking possession of time and space through the intermediacy of symbols, to a domestication in the strictest sense of the term, since they lead to the creation of controllable space and time within the home and radiating outward from the home.

As a result of this symbolic "domestication" the human was able to pass from the natural rhythmicity of seasons, days, and walking distances to a rhythmicity regulated and packaged within a network of symbols—calendrical, horary, or metric—that turned humanized time and space into a theatrical stage upon which the play of nature was humanly controlled. The rhythm of regularized cadences and intervals took the place of the chaotic rhythmicity of the natural world and became the principal element of human socialization, the very image of social integration, to a point where our triumphant society's framework is today a checkerboard of cities and roads on which the movements of individuals are controlled by horary time. The link between humanized space-time and society is perceived so strongly that for some centuries an individual desiring to recover his or her spiritual balance has had nowhere to go except to a monastery or a desert cave, ending up like St. Simeon Stylites or the Bodhisattva in a contemplative immobility that is a rejection of both time and space.

Time

The separation of space from time is a purely technical or scientific convention. When we say that Moscow is three and a half hours flying time from Paris, we communicate a richer reality that if we alluded to the 2,500 kilometers that separate the two cities: richer because it includes the concept of distance as an experience, just as in the year 1800 it could be said that Lyons was five days away from Paris. By the same token, when we tell the time by looking at a clock we are connecting time to the spatial position of the clock hands. If time exists at the ethnological level, it is as a simple abstraction, as one of the twin poles of rhythm.

The first evidence of rhythmic expression is provided by the bone fragments or stones marked with regularly spaced incisions that appeared toward the end of the Mousterian period and were already very abundant in the Châtelperronian around 30,000 B.C. (figure 82). As we saw in chapter 6, the hypothesis I consider most likely to be true is that these series of strokes corresponded to the rhythm of words. It is difficult to imagine that they expressed distances, and there is nothing whatever to support the hypothesis that they were in any way related to accounting. That they represented the essential animal rhythm, that of the heartbeat, is not impossible but cannot be demonstrated. Whatever their meaning, these records—which antedate the first systems of measurement by many thousands of years—testify for the first time to rhythms perceived at regular intervals. The few regular rhythms that the natural world offers include that of the stars, that of seasons and days, that of walking, and that of the heart—all of them, in different degrees, giving priority to the concept of time over that of space. Upon these nature-given rhythms we have superimposed the dynamic image of rhythm created and fashioned by human gestures and vocal emissions and, lastly, the graphic records inscribed by hand upon bone or stone.

Human time is and remains an ambiguous measure because natural rhythms are shared by all living matter. The measurement of lived time refers to phenomena unrelated to measurement as such. The study of calendrical systems is of interest in this respect. In all agricultural-pastoral civilizations, the complex movements of the stars have engendered astronomic reference systems that tend, whether it be among the Mayas, the Chinese, the Egyptians, or the Romans, to order the passage of the seasons geometrically within a grid established by the periodically recurrent position in space of some of the main celestial bodies. Endeavors to ensure regularity of the calendrical grid are inseparable from advances in computing space and quantities. The measuring of grain or of herds, the architectural integration of the world, play a far more decisive role in the elaboration of a system of time measurement than the abstract concept of ideally equivalent intervals. If we disregard the "time specialists" who appeared around the time when the first urban settlements were formed, the fundamental concept of duration is apprehended only through the recurrence of produce or operations necessary to life. The calendar of primitive peoples or of farmers, constructed upon mythical time, is a cycle marked by the return of certain game birds or animals, the ripeness of certain plants, the tilling of the soil; time in such a calendar is a concrete, operational entity in which astronomical bodies participate either as copartners within the vast technicoreligious machine or as remote dispensers. The periodic return of the seal for the Eskimo, the sprouting of corn for the farmer, give rise to a time symbolism in which religious thought is applied in the first place to the operational reality. The development not only of an abstract measurement of time but also of an ideology that attributes to the stars the role of supreme deities came only when agricultural societies had reached a highly urbanized stage. It was not by chance that eighteenth-century travelers unhesitatingly described almost all the peoples they encountered as being sun or star worshippers, while at the same time the French revolutionary calendar attempted to relate time to the activities of agricultural and technical life. On the one hand, the thinking of philosophers was permeated by the extraordinary importance assumed by astronomical machines and by the millenary traditions of astrology, while on the other the practical traditions of the farmer's year were used as an antidote to divine time.

The individualization of time reflects the gradual integration of individuals in the social superorganism: Over tens of thousands of years a fabric of symbols, extremely loosely woven in the early stages, became superimposed upon the complex and elastic movement of natural time. The life of animals is no less regular than that of the nineteenth-century peasant—"up with the sun, to bed with the fowls"—both are still integrated within a cycle governed by a trilateral contract among nature, the individual, and society. But what was true of rural life until the twentieth century had no longer been true for several centuries of the urban environment and especially of its most socialized strata, the religious and military classes. For these, the progress and survival of the social group depend upon abstract time. Their motor and intellectual integration rests upon a vigorous rhythmic system materialized in bells and bugles, signals of a code of integration as well as segments of time. Faced with the need to ensure the collective's survival—for in all major religions the normal course of the universe depends upon the punctuality of sacrifices—the religious were the first, at the very dawn of civilization, both in the Old and in the New Worlds, to divide time into ideally regular segments, thereby becoming the dispensers of months, days, and hours. Not until recently, with the integration of the masses in a social mechanism where any failure on the part of a specialist can cause collective disorder, did symbolic time assume an absolutely imperative value. In earlier chapters we have seen on several occasions that the liberation of a faculty always leads to accelerated improvement, not of the individual as such but of the individual as an element of the social supermechanism. Expressed a thousand times by sociologists of all persuasions, this fact arises from the existence, parallel with biological evolution, of the stream of material development that sprang forth from the human as soon as language had pierced the confines of the concrete. It has led to the exteriorization of tools (already achieved much earlier as a fundamental condition), of muscle, and eventually of the nervous system of responsiveness. The exteriorization of time took place simultaneously but along different lines; time became the grid within which individuals became locked at the moment when the system of responsiveness reduced the period required for transmission to hours, minutes, and eventually to seconds. In sectors where the limit has been reached, the individual functions as a cell, an element of the collective program, within a network of signals that not only control his or her gestures or effective mental activity but also regulate his or her right to absence, that is, to rest or leisure time. The primitive individual comes to terms with time, but perfect social time does not come to terms with anyone or anything, not even with space, for space no longer exists except in terms of the time required to travel through it. Socialized time implies a totally symbolic humanized space like that of our cities where day and night fall at prescribed hours, summer and winter have been reduced to average proportions, and the relationship between individuals and their place of activity is instantaneous. This ideal has been only partially achieved; we need only think what the urban lighting, heating, and public transport must have been like a century ago to acknowledge that much of the journey is already done.

Humanized Space

We belong to the category of mammals that spend part of their existence inside an artificial shelter. In this respect we differ from the monkeys—among whom the most highly developed make only rough adjustments to the place where they will spend a night—but resemble the numerous rodents whose elaborately constructed burrows serve as the center of their territory and often as their food store. The subject of human territorial behavior was discussed in chapter 5; here we shall consider the humanized image of the territory.

Even fragmentary information about the earliest beginnings of humanly organized space is lacking. The Australanthropians have not yet yielded up any habitat that could be studied in detail, the Sinanthropians left their traces in a cave in which concretions made observation extremely difficult, practically nothing is known until the Palaeoanthropians. According to a deep-rooted scientific tradition, prehistoric humans lived in caves. If this were true, it would suggest interesting comparisons with the bear and the badger, omnivorous and plantigrade like ourselves, but it would be more correct to suppose that although humans sometimes took advantage of caves when these were habitable, they lived in the open in the statistically overwhelming majority of cases and, from the time when records become available, in built shelters.

Although records are rare, they fortunately relate to the period during which the Palaeoanthropians evolved into *Homo sapiens,* that is to say, just before and just after the advent of the first graphic symbols. It is therefore reasonable to assume that Mousterian habitats represent the ultimate stage of the archaic Anthropians' development of space, whereas Upper Paleolithic habitats represent the beginnings of the stage still going on today.

Exact surveys are available of three Mousterian habitats, one in the open air at Molodovo on the Dniester and the other two in caves (the Hyena and Reindeer Caves at Arcy-sur-Cure in the department of the Yonne in France). They differ quite considerably in form, the Soviet site (figure 111) being a circular one about 8 meters in diameter, which suggests the presence of a tent or hut, the Hyena site occupying a space of 5 to 6 meters diameter, and the Reindeer site being part of a gallery, 2 meters wide by 5 to 6 meters long (figure 112). The similarities among the three habitats are, however, striking. Each consists of a central area where the hearths were situated and which were found relatively free from animal remains but rich in stone tools, surrounded by a thick peripheral ridge of scraped and crushed bones. Leaving out of account the structure which must have existed at Molodovo, the reconstituted picture is rather meager: Neanderthal man lived surrounded by carcasses of his game, which he pushed aside in order to provide himself with living space.

The contrast with habitats dating to around 30,000 B.C. is striking. The earliest are the Châtelperronian ones found in the Reindeer cave at Arcy (figure 113). Comparison is facilitated by the fact that they are situated at the same spot as one of the Mousterian habitats discussed in the preceding paragraph. These habitats are the sites of tents built at the entrance to the cave. Each forms a circle 3 to 4 meters in diameter with a central area of clay that has been cleared of stones and compacted, surrounded by a ring of stone slabs forming a pavement. Outside the circle vertical holes were provided for the insertion of large mammoth tusks forming a frame. The whole space was carefully maintained; a few piles of coarse rubble, and scattered on the slope, some "rubbish bins"—small heaps of ash intermingled with discarded scraps of flint and small bone fragments—were found outside. Thus the earliest point in time at which figurative representation appears is also the moment when living quarters begin to be set apart from the outer chaos. The role of the human as the organizer of space manifests itself here in the systematic adaptation of space. This most ancient example is confirmed by the numerous tent or hut sites—vestiges of circular or elongated dwellings with their hearths and their bone pits—discovered in Moravia, the Ukraine, and Russia. In France recent excavations conducted more meticulously than in the past have resulted in the discovery of similar dwellings constructed in caves or beneath overhanging rock. Still more recently, a very large Magdalenian camp site was found at Pincevent near Montereau.

Organization of inhabited space is not only a matter of technical convenience but also, by the same token as language, the symbolic expression of globally human behavior. In all known human groups the habitat meets the threefold requirement of creating a technically efficient environment, establishing a framework for the

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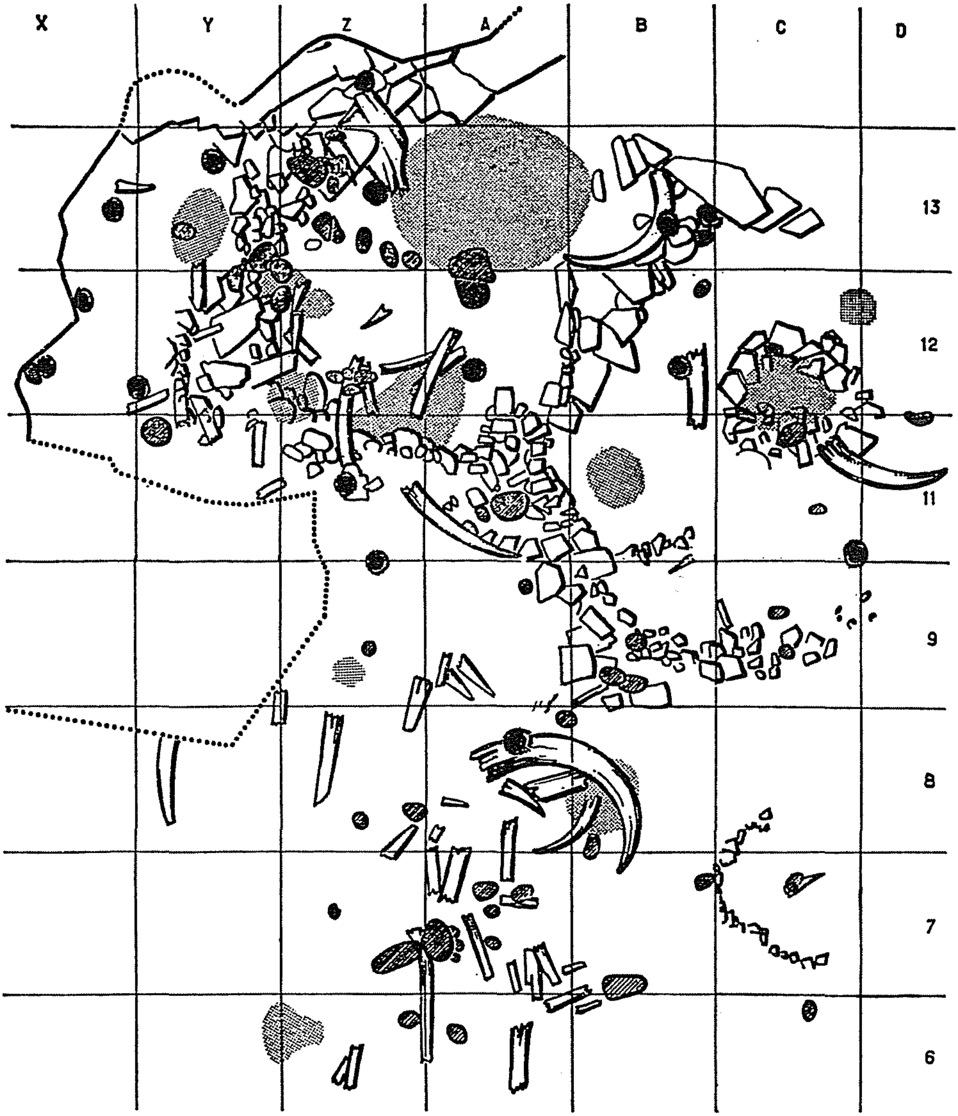
111. Tent or hut site, Mousterian (before 40,000 B.C.). The traces of this dwelling, discovered at Molodovo in the U.S.S.R., are marked by a circle formed of animal remains.

112. Mousterian habitat in a remote gallery of the Reindeer cave at Arcy-sur-Cure.



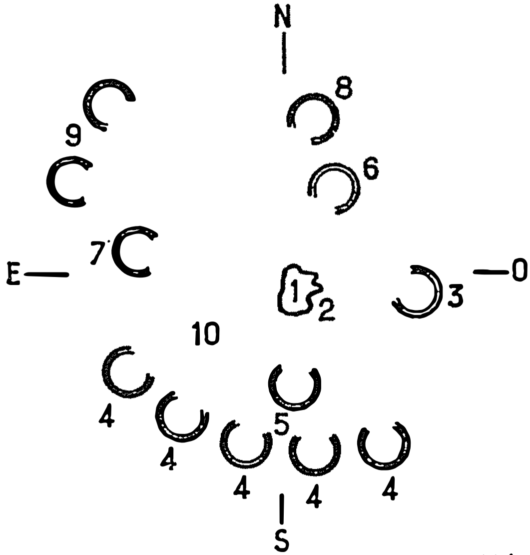
113. Site of huts built under the porch of the Reindeer cave at Arcy-sur-Cure. Châtelperronian, about 36,000 B.C.).

social system, and providing a starting point for the work of ordering the surrounding universe. The first of these properties forms part of functional aesthetics and has been discussed earlier: Every habitat is clearly an instrument, and for that reason is subject to the rules that govern the relationship between function and form.

Social Space

A century of sociology has taught us that the dwelling and, more broadly speaking, the habitat is the concrete symbol of a social system. The layouts of the camps of Bushmen or Indians of the American southwest, or of Amazonian or New Caledonian villages (figures 114, 115, and 116), expressing as they do the separations between families and clans within the topographical unit, are classic examples. We need only turn the pages of the Paris trade directory to realize how closely the same rule still applies to a modern city.

It would be most interesting to determine the date of the earliest traces of social functionalism in the human habitat, and in particular to investigate the possible convergences between sociospatial organization and technoeconomic evolution. The evidence from late prehistoric times is perfectly obscure; nothing in the lair of Mousterian man can reasonably be perceived to imply social divisions. The perspectives opened up by habitats of the Upper Paleolithic are clearer: Their often very poor state of preservation notwithstanding, the organically constructed character of these habitats and the diversity of objects found in them can shed some light on the question. One almost ideal case, that of the Upper Paleolithic dwellings found at Mal'ta in Siberia, does exist (figure 117). These are extraordinarily well-preserved tent sites in which the archaeologist, M. Gerasimov, was able to verify several times over that the hearths to the right and the left of each dwelling were surrounded by objects of a different kind, with female statuettes, awls used in sewing, and scrapers used for working animal skins near the former and statuettes of birds, spears, knives, and large awls near the latter. In one case at least we find, at the level of the primitive economy, the two complementary elements of the man/woman couple expressing themselves topographically through a separation between male and female furnishings. The present-day Bushman encampment (figure 114)—with its communal fire for men and individual fires for each woman and its huts for couples, little girls, and adolescents—reveals a very similar sociofunctional organization. The igloo topography of Eskimo households also reflects a precise delimitation of the man's and the woman's respective spheres. The basic character of societies with a primitive econ-



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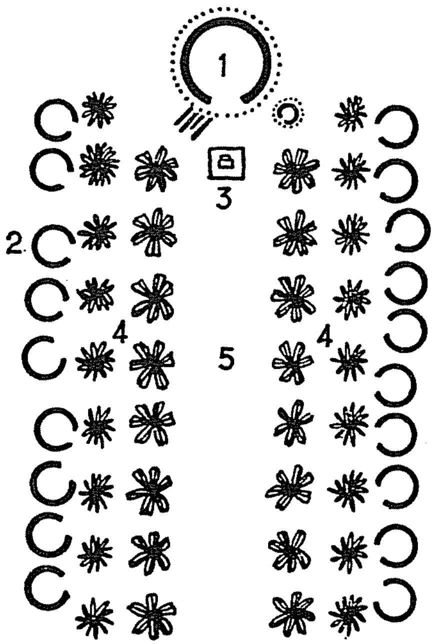

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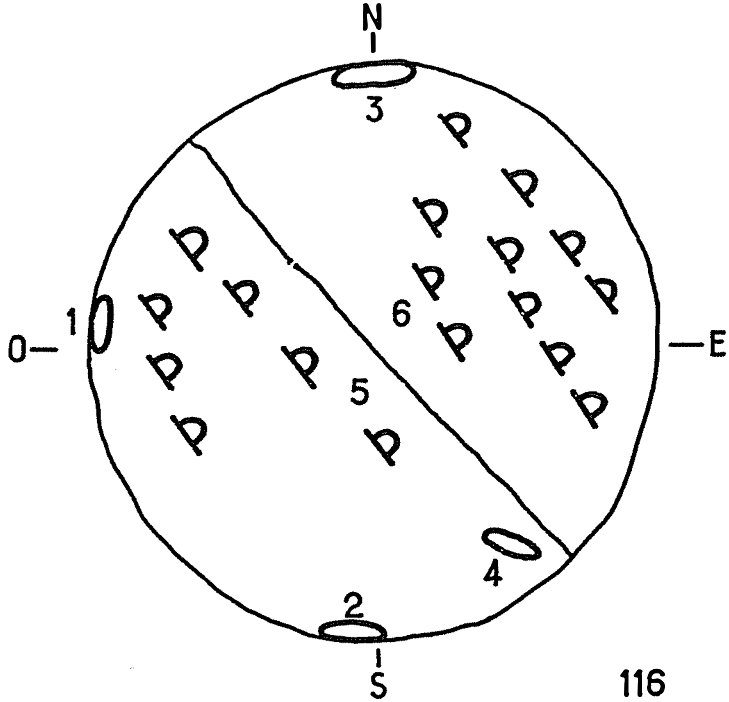
114. Encampment of Bushman hunters: (1) Central tree beneath which the men gather and where they deposit their game; (2) the men's camp fire; (3) the chief's hut; (4) huts for families and girls of marriageable age; (5) younger girls' hut; (6) adolescent boys' hut; (7) visiting girls' hut; (8) visiting sisters' hut; (9) widowers, widows, strangers; (10) dancing area (after W. H. Bleek).

115. Kanak village, New Caledonia: (1) Men's hut, (2) family huts, (3) altar, (4) women's alleyways (family rites), (5) Men's alleyways (clan festivals, banquets, dances) (after M. Leenhardt).



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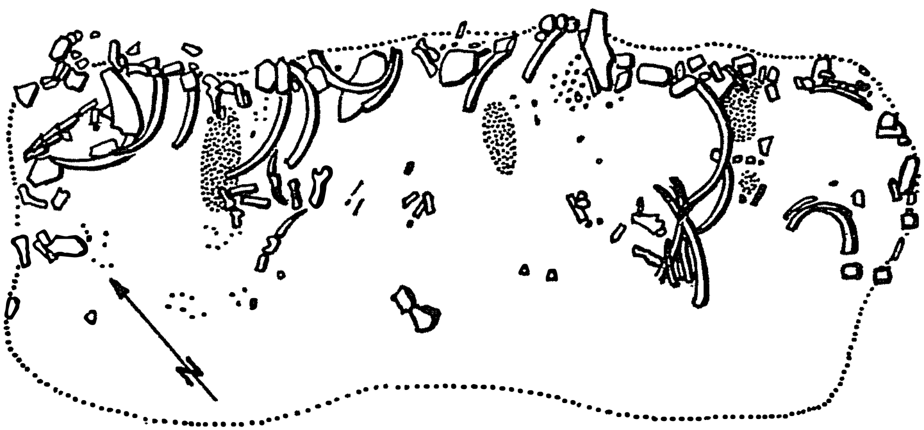

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116. Winnebago Indian village, in two complementary halves: (1) to (4) Community cabins of the warrior (1), thunderbird (2), bear (3), and bison (4) clans. (5) Family cabins of the upper phratry; (6) family cabins of the lower phratry (after P. Radin).

117. Vestiges of an Upper Paleolithic tent at Mal'ta, Siberia. The women's chattels were grouped on one side of the lateral fireplaces, the men's on the other (after M. Gerasimov).

omy finds expression in an organization of space within which the dominant social division is governed by the technoeconomic functions of the couple.

Only a few archeological records concerning the earliest agricultural economy are as yet available. Much archaeological work still remains to be done. Until now archaeology's main concern has been with establishing a chronology. An interpretation of how objects were used, of whether they were employed by men or by women, of their position within the inhabited space must await further excavations oriented toward a more comprehensive recording of facts. Plans of villages exist, but few are complete, and none is detailed enough to show the precise position of all objects. Tombs are more clearly circumscribed and have therefore been better studied. In some cases where the collective burial place mirrors the world of the living, as in the artificial caves of the Marne, it is possible to form a sociological view. Nevertheless, the time when a major part of a fossil record will no longer be lost to the scholar lies far in the future. What we can dimly glimpse through archaeological evidence concerning nonurbanized agricultural societies in all parts of the globe is the relative uniformity of inhabited elements within the village as a whole, the frequency of very large dwellings with separate hearths, and communal burial places without any apparent social hierarchy. Although subject to many variations, these facts are also true of modern nonurbanized agricultural societies, particularly in America, Oceania, and Indonesia, on the fringes of the urbanized world; they correspond to a technoeconomic stage where the couple begins to yield in importance to larger units and where the society ensures its cohesion through diverse complex kinship systems designed no longer to protect individuals but to balance family groups by means of matrimonial and economic arrangements. As with the evolution of the brain or of tools, structures are superimposed on one another without being mutually exclusive. The latest one to develop is based on the preceding one so that the importance of the couple survives as an infrastructure just as that of the extended family will survive, becoming added to the preceding structure, in subsequent stages. The spatial system of elementary agricultural societies already seems very different from that of primitive hunters and gatherers, for, as we saw in chapter 5, settled existence transformed not only the social apparatus but the very image of the world.

Itinerant Space and Radial Space

We perceive the surrounding world in two ways, a dynamic one whereby we travel through space to take cognizance of it and a static one that enables us, while remaining immobile, to reconstitute circles around ourselves extending to the limits of the unknown. The first offers an image of the world linked to an itinerary; the second integrates the image within the two opposing surfaces of sky and earth meeting at the horizon. These two modes of perception are found separately or together in all animals, the itinerant mode being particularly characteristic of land species and the radial mode of birds. It could also be said that the former is connected with predominant muscular and olfactory perception, while the latter principally concerns species with a developed sense of vision; the classification is only a very rough one, for the wolf when resting undoubtedly perceives the world in the form of "olfactory surfaces." In the human the two modes are coexistent and essentially linked with vision. They have given rise to a dual representation of the world in which both modes operate simultaneously but in relative proportions that were apparently reversed on settlement. The principal contents of the mythology of hunters and gatherers are images of trajectories—trajectories of celestial bodies and the travels of heroic figures. In many myths from various parts of the world, including the preagricultural substratum of Mediterranean civilizations, the universe is initially chaotic and peopled by monstrous entities. In the course of his itinerary, the hero fights the monsters, regulates the position of mountains and rivers, and names the animals, thus transforming the universe into an image symbolically assimilable and controllable by the human. The mythologies of North American Indians provide fine examples of such "organizing" itineraries; among Mediterranean examples, the myth of Hercules suggests that the first urban civilizations probably assimilated the remains of an earlier ideology.

It would be particularly interesting to be able to form an idea of Paleolithic man's image of the world. Prehistoric art ought to be of great help in this respect, but the choice of figures in cave art and the manner in which these figures are organized are at first glance baffling. Until recently cave art was seen as essentially magic in nature, but now it appears to have been a more general figurative system, a real mythology including couples of male and female figures, pairs of animals—for the most part a bison and a horse—and a third animal, generally an ibex, stag, or mammoth. The figures are distributed over several "rooms" and follow the topographical layout of the cave in a progression, with big cats and rhinoceroses appearing in the final room. Any layout in which the figures surround the artist who executes them reflects something of the artist's image of the humanized universe. Nothing of the radial mode is to be seen in cave art; the perspective needed to symbolize the two surfaces is lacking. The organization of the figures has confused scholars for a long time because its order is alien to ours and we have tended to view it as haphazard and chaotic. Discovered by torchlight, the figures of Lascaux are ordered, not in separate panels, but along a trajectory and connected with one another by the link of a theme whose meaning escapes us but which is repeated again and again until the rhinoceros figures are reached at the very bottom of the cave. The situation is even more palpable at Niaux, where the images forming small groups stretch over more than a kilometer, and more palpable still at La Cullalvera (Santander province, Spain) where a single version of the theme is repeated, figure by figure, at intervals of several hundreds of meters over a total distance of 2 kilometers. Is Paleolithic art a real cosmogony? The contrary is far from being proved by the absence of any representation of astral bodies after our own fashion, but neither is there anything to prove definitively that it is. Whatever the meaning of the myths, their linear ordering and the occurrence of repetitions are positive facts.

Radial Space

The nomad hunter-gatherer visualized the surface of a territory by crossing it; the settled farmer constructed the world in concentric circles around a granary. The earthly paradise was a garden laid out against the side of a mountain, with the tree of knowledge in its middle and with four rivers flowing from it to the ends of the earth. This image bears no relation either to the Lascaux cave painting or to the Herculean myth. Everything within it has been named by the human being (and therefore exists symbolically), but the naming appears to have been done on the spot, within the Edenic center itself. The form in which the Book of Genesis has come down to us provides an ideal illustration of how a society at an already advanced stage of settled agriculture sees the world. Practically the same is true of the cosmogonies of the great American civilizations or of China, societies already marked by the trend toward systematization that sprang from writing. It is not easy to visualize the evolution that took place in the five or six thousand years of the agricultural revolution antedating all written records. The innumerable cave painting figures of Europe, Africa, and Asia between the end of the Paleolithic around 8000 B.C. and the Bronze Age shed only a very faint light upon the subject, but they do contain two aspects absent from Paleolithic art, namely real scenes of the hunt, of tilling, or of animal breeding activities, and representations in plan or in perspective (figure 93) in which dwellings are included. Here too solar wheels and lunar crescents are seen for the first time. Excavations by J. Mellaart in Anatolia in 1961 revealed part of an Early Neolithic village dating back to approximately 6000 B.C. in which the walls of several houses were decorated with frescoes (figure 118). These earliest known mural paintings represent extensive scenes in which figures of bulls and stags are surrounded

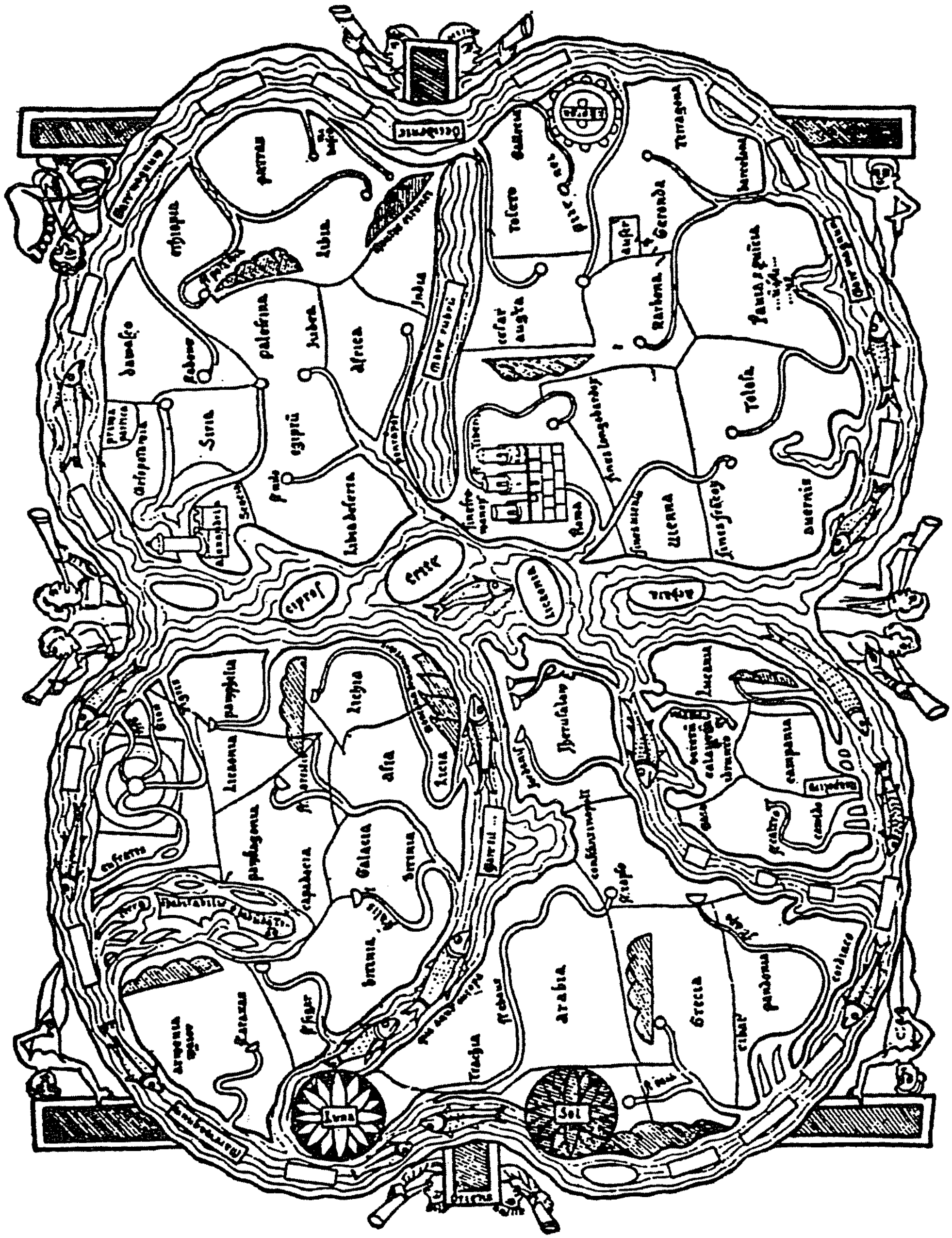
118. Çatal Hüyük, Anatolia. Neolithic frescoes, seventh century B.C. *(after J. Mellaart).*

by individuals armed with bows (hunters or dancers). The general design and the subjects are not dissimilar to the at least 3,000 years more recent Minoan frescoes of Crete. This extraordinary discovery demonstrates to what an extent, from the very beginnings of agriculture, settled existence imprinted a new form upon the whole setting of social life. The thick-walled, closely spaced quadrangular houses, with their interior courtyards and their decorated rooms, the dead buried under platforms which probably served as beds for the living, and walled granaries, constitute a totally humanized microcosm surrounded concentrically by fields, forests, and mountains.

Microcosm and Macrocosm

Although records do not yet provide us with the details of an evolution, the earliest texts reveal a system of symbolic representation of the universe which, in broad outline, is astonishingly similar in America, China, India, Mesopotamia (figures 76 and 78), Egypt, and wherever a culture was entering or was about to enter upon the era of writing. Such a system involves siting the capital city at the intersection of cardinal points and constructing a code of correspondences which gradually assimilates all creation within its system (figure 119).

With urban centralization, symbolic data referring to space and time assume a preponderant value, and as we have seen, technoeconomic development leads to

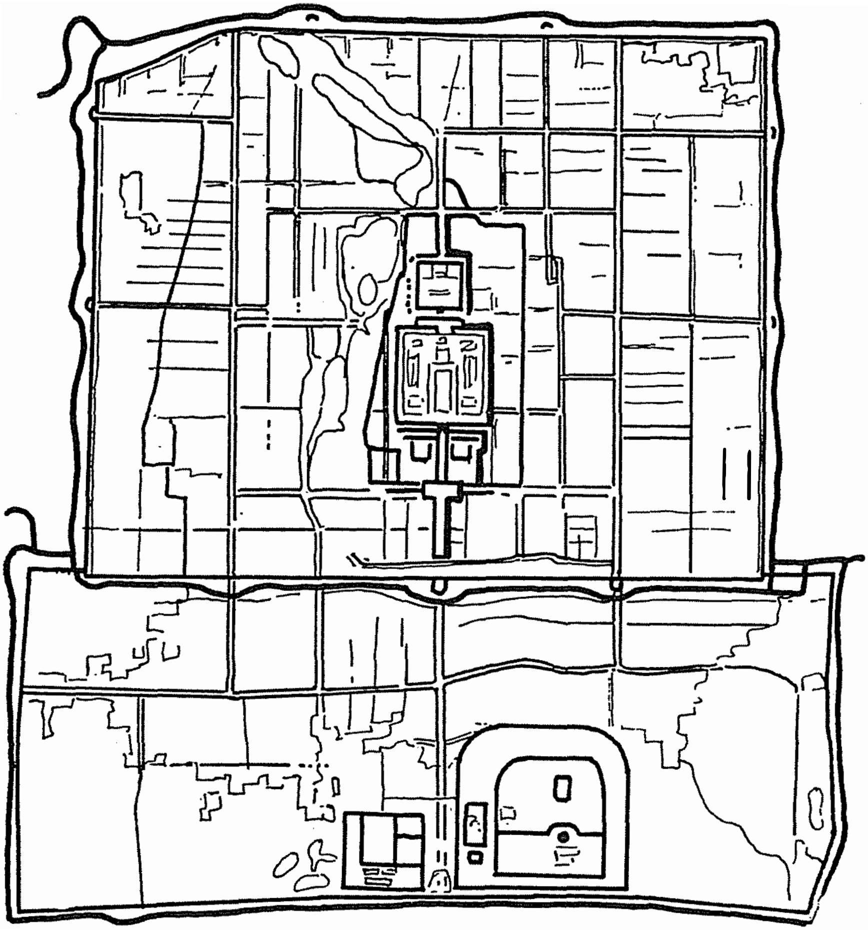


119. Twelfth- or thirteenth-century copy of a map of the world drawn by the monk Beatus in the eighth century A.D. *The land part, surrounded by a circular ocean and cut crosswise by the Mediterranean and Red seas, consists only of parts of Eurasia and Africa known in antiquity. A purely logical construction, with Rome and Jerusalem, located at the center, facing each other. Eden, with its four rivers forming a cross, is situated at top left, separated from Mesopotamia by the sea and Alexandria.*

the concurrent emergence of the fire crafts (metallurgy, glassmaking, pottery), writing, monumental architecture, and a crude social hierarchy, all of which make the ethnic group's capital into a fully humanized kernel at the center of the territory that feeds it. This technoeconomic process has recurred hundreds of times since agriculture first became settled, sometimes as part of a larger historical development but sometimes apparently in isolation. Its causes are connected with technical determinism, and therefore in theory it is as futile to look for traces of historic links between Mesopotamia and the Mayas as it is to see in them the effect of automatic convergence, for either may be true. The same applies to the cosmogonies or metaphysical systems proper and common to all agricultural civilizations of a technoeconomic level corresponding to the earliest urbanization. The first settled view of the universal order was extraordinarily logical and rational; all of its elements were neatly ordered and interconnected; and what has been regarded as the mysterious science of the Egyptians, the Chinese, the people of Atlantis, or the Mayas has the same quality of attraction. It is not altogether idle to wonder why this "science" emerged at the same time as the penal code, the built esplanade, and money lending against a written undertaking.

The existence of a fully humanized area and the integration of that area in the surrounding universe give rise to problems as specific as those of the integration in space of individuals: The collective organism must accomplish its spatial integration in a process of movement. The integration of individuals in the urbanized organism is accomplished by rhythms that control the conditioning of the group. Urban time, as we have seen, is humanized time par excellence, but the integration of the kernel formed by humans and their technoeconomic environment can only take place as part of an effort to establish an ordered continuity between the humanized kernel and the aureole of the natural world that surrounds it.

This ideal continuity is found in the movement of the heavens which provides the intersection of the cardinal points or any other astral reference point regarded as fixed. The city is then situated at the center of the world, and its immovability guarantees, as it were, that the heavens are pivoted upon it. As the central point of the heavens and the earth, it is integrated in the universal apparatus whose image it reflects: The sun rises to the east and sets equally far to the west of *the city,* and its inhabitants are inclined to believe that, beyond their aureole, there exist less fortunate places much closer to the West—the home of darkness—or to the rising sun in the East. The city's West and East are West and East par excellence, for they mark the exits and entrances of the heavenly body in a completely humanized and symbolical microcosm (figure 120).

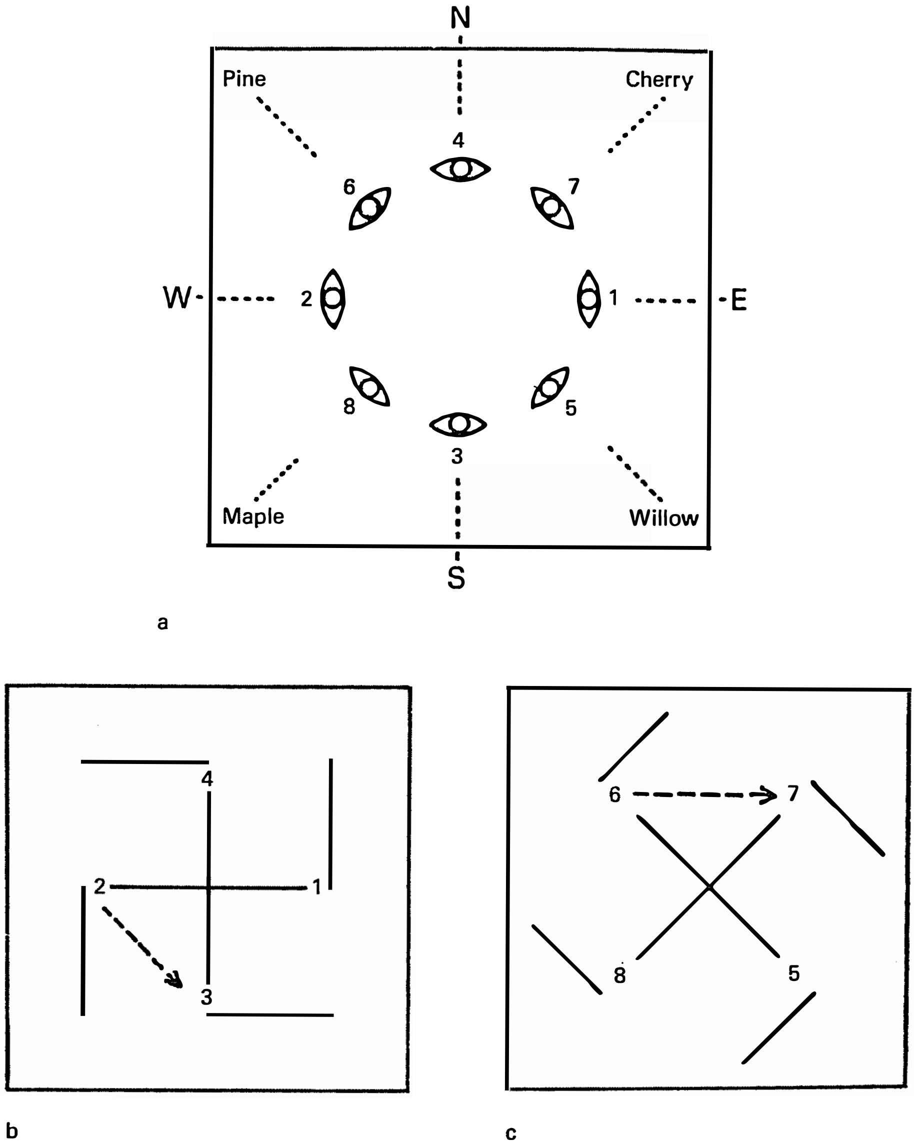


120. Plan of Peking: Geometrically oriented city. The imperial palace is in the center, the entrance facing south.

For reasons that connect architecture with writing and with spatial integration, the city is the reference point of metrology. Land surveying plays a major role, and the farthest confines of the earth are connected by the symbolic radii of the wheel of distances. The result is a geometrical image of the world and of the city involving a whole network of corresponding spatial elements. If the city gates coincide with the cardinal points, the north gate need only be called "Winter Gate," and the symbolism of space will be enriched with the dynamics of time. The people of the city need only go to each gate in turn in order to let in each season, and the result will be not only spatiotemporal integration but also mechanical control of the universal machine. This process, which is described here as a gradual one, is only the adaptation of one of the properties of language—or, more broadly, of the faculty of symbolization—to the city regarded as an umbilicus. This absolutely general property requires that the symbol shall control the object, that a thing shall exist only once it has been named, that possession of the symbol for the object shall bestow the faculty of exercising an effect upon the object. This attitude, which we ascribe to "primitive societies" in their "magic" practices, is just as present in the most scientific modern behavior, for phenomena can only be grasped to the extent that thought can, through words, exercise an effect upon them by constructing a symbolic image that will then be brought materially into existence.

The connection between the geographical East and the East Gate is therefore a normal connection between the object and its symbol. It is the fundamental property of cities to provide an ordered picture of the universe. Order is introduced through the city's geometry and through the measuring of time and space. Life is maintained by identifying the symbols for the movement of heavenly bodies with that movement itself or by believing that it is the symbol of plant rebirth that actually causes plants to grow. Historians of religion have demonstrated the highly generalized nature of ball games as symbols of the solar year: Common in the Americas, in China, and until recently in Japan, they have been the source of ceremonies of a most elaborate cosmogonic character (figure 121).

In the geometrical and oriented capitals of the Chinese and Japanese, the imperial palace occupies the place of honor, its back abutting on the north wall, its façade facing southward. Within the palace enclosure, the ball-game field too is geometrical and oriented, with a cherry tree (spring) in the northeast corner, a willow (summer) in the southeast, a maple (autumn) in the southwest, and a pine (winter) in the northwest. Two groups of four players, arranged in a circle, must bring the ball down from the branches of the tree of spring and kick it twice round the field in opposite directions, stopping in turn at the corner of each equinox and solstice. Then each player



121. Layout for the traditional ballgame (ancient China, Japan): (a) Playing field, position of the players and order of play. (b) and (c) Figures ideally described by the ball, forming two swastikas rotating in opposite directions.

must kick the ball diagonally across the field by a series of shots zigzagging east–west and north–south.

The movement of the universe is not only rotary but also alternating and contrasting: cold from the north and heat from the south, youth from the east and old age from the west, and so on, so that each part of the universe (and of the city) corresponds to a quality as well as to a cardinal point. Once this is established, the human being holds the key to the universe, and astonishing bodies of knowledge founded entirely upon the play of contrasts and identities and encompassing the whole of known reality from numbers to medicine and from architecture to music, come into being in different but ultimately convergent forms. In ancient China there were five elements, five heavens, five kinds of animals, musical notes, scents, numbers, places of sacrifice, bodily organs, colors, tastes, and divinities to correspond to the four cardinal points and the center. Obviously therefore the South, summer, birds, the smell of burning, the hearth, the lungs, the color red, bitterness, the figure 7, and the note *chou* have properties in common and can be used to act upon one another. Perfect spatiotemporal integration has been achieved, and the human is completely safe because everything is explained, grasped, and assigned to its proper place. Sometimes the moon cannot be prevented from eclipsing the sun, but it is important to know that this is due to the excessive influence of the feminine principle; you can then reform the heavens by reforming the actions of the inhabitants of the humanized microcosm. The Aztecs too had such systems, as did the Greeks and the Egyptians. As recently as the sixteenth century, European thought was still dominated by similar systems, and some African societies still preserve a philosophy based on these principles. To regard them as the fruit of an incompletely formed intelligence is as mistaken as to find in them traces of a mysterious and perfect knowledge that has allegedly come down to us in mutilated form. The miraculous aspect of cosmogonic thought is all the easier to exploit as it corresponds to constructs made of completely logical and verifiable facts, develops along lines spontaneously accessible to human reason, and leads to a set of formulas that mysteriously explains everything. The ancient wisdom of the Egyptians, or the Tibetans, will be invoked for many years yet, together with what survives of the Cabbala, the Pythagorean philosophy, and the secrets of the pyramids or the cathedrals, because it really *was* wisdom—that is, reflection and the search for an explanation that might soothe human anguish at existing, alone in the midst of nature's chaos, as the creator of order. Cosmogonic thought is historically venerable because it accompanied civilization through its earliest scientific development. It is still accessible to our minds, just as the no less ancient sickle is still manipulable by our hands, although it is difficult to believe that the sickle is the evanescent reminder of miraculous combine harvesters used by the people of Atlantis to bring in the crops of their forever vanished fields. Science, like technology, obeys the laws of a certain historical logic.

Antiquity

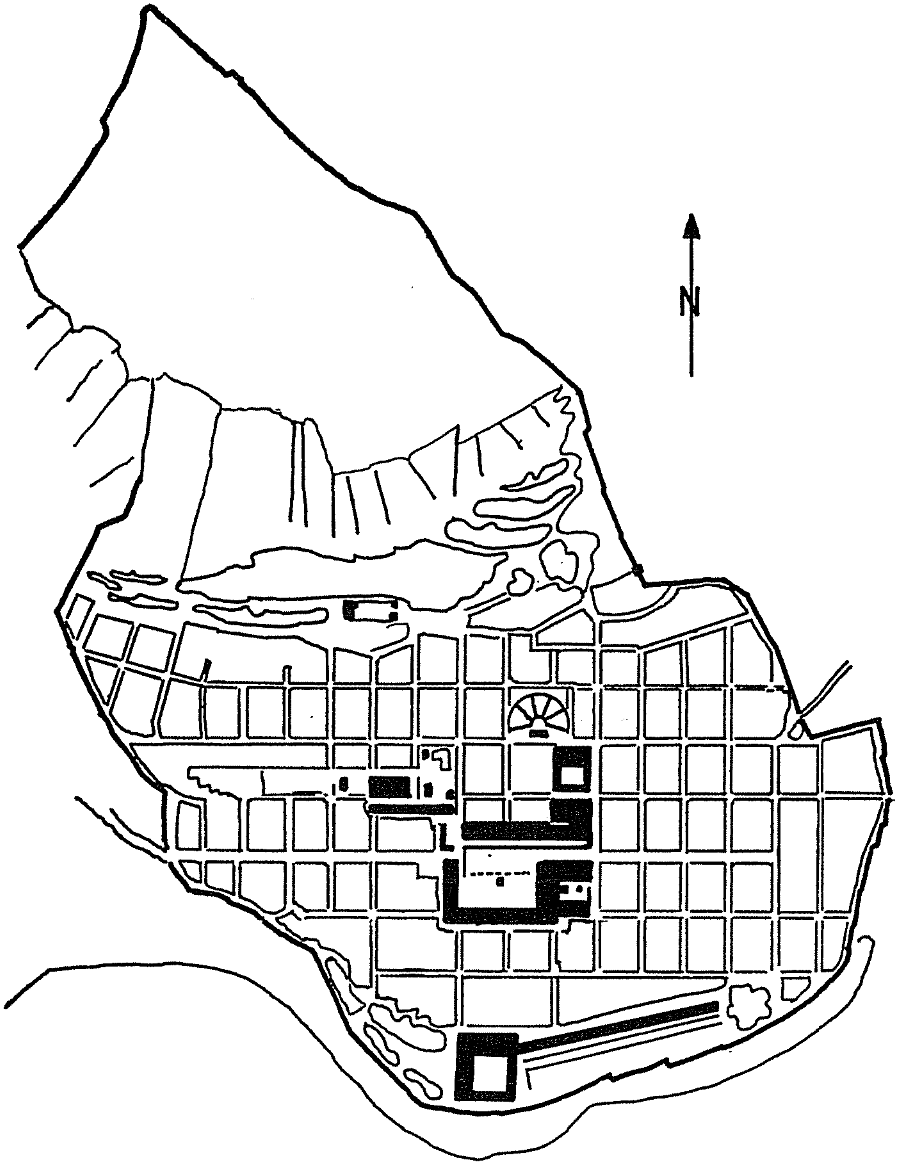
The integration of humanized space in the external universe takes place according to certain fundamental laws which, not surprisingly, are met with at all stages of human history, whatever the level of technoeconomic or ideological evolution of the particular group concerned. That which expresses itself in the human through architectural or figurative symbols applies in animals to the most elementary forms of acquisitive behavior; the physical and psychic balance of species which, like humans, draw a distinction between the refuge and the outside world rests upon comings and goings between the shelter and the territory. It is therefore only natural that the "shelter/territory" relationship should be the main term in the formula of spatiotemporal representation and that the form of the shelter should not simply meet the practical requirements of protection and economy but also serve as the hinge between shelter and territory, between humanized space and untamed universe, the twin terms of spatiotemporal integration both static and dynamic.

As we have seen, a tremendous break occurred when the primitive world adopted a new mode of integration in space through the settling of agriculture. Although no change in the basic ground plan was possible once that mode was established, major variations did take place, and they affected the ideology underlying the choice of forms. To put it differently, once the ground plan for the most ancient cities had been drawn, there was no reason for fundamental change throughout Antiquity, the Middle Ages, and down to the present day. Throughout its history the city must preserve its cosmogonic character, but the manner in which it is perceived as the image of the world may be profoundly altered by ideological evolution and historical circumstances.

Creating an artificial area within which the human is isolated as in a magic circle is inseparable from being able to introduce into that area, materially or symbolically, the controlled elements of the external universe. Integrating the granary, repository of nourishment, is not so different from integrating the temple, symbol of the controlled universe. Transposing this proposition to the animal level, we can say that there is no categorical distinction between the burrow as a refuge and as a store of consumable goods. In the Mesopotamian city and the Dogon village alike, the temple and the storehouse are close to one another; indeed they are linked together within a close ideological network. The reason why the fabric of symbols that covers the functional reality of human institutions exhibits such extraordinary coincidences is precisely because the underlying forms are so deeply similar.

It is a striking fact that the cities of classical Mediterranean antiquity within the Greek or Roman spheres of influence retain a geometrical layout directly inspired by archaic architectural ideas, although, by the time they were built, the old ideology of effective correspondences had already faded (figure 122). Right into the modern era processions went on reproducing the movement of heavenly bodies and sacrifices signaled the start of the agricultural cycle, but they did so in an intellectual context with explanations supplied by functional realism. This is particularly noticeable in the development of the Roman world where, although every action was still imbued with religious significance, the rational development of the sciences had already begun to furnish a lateral explanation of the universe. A great distance already lay between the Heraclean world, or that of Gilgamesh, and the universe of Herodotus or Seneca. By a process already described many times, a new explanatory mode came into being—the mode of scientific explanation which, without completely eliminating the preceding stages, relegated them to halftones. A parallel with the present situation of astronomy and astrology comes to mind: No one would dream of questioning the scientific reality of the sidereal universe upon which our feeling of universal integration is now founded, yet a thousand times more human beings read horoscopes than works of astronomy. The old system of cosmogonic correspondences has survived in the background. Although contact between Mars and Earth is now established in the observatory and not in the ancestral temple, there is still a direct link between the planetary symbol and individuals born under its sign whom this imaginary connection provides with the essential feeling of cosmic integration.

The capital city remains the center of the world because its entire universe converges upon it. What was once a metaphysical explanation assumes forms very close to those still known to us today. Exoticism—our cult of exotic objects, zoos, circus acts involving elephants, lions, and Blackamoors—bears witness to the forms taken by spatial integration in the ancient world. The city is no longer just the point of convergence of cosmic influences; it tends to create within itself a highly material image of the natural universe that surrounds it. The problem of reintroducing nature into superhumanized urban space is not just a problem of the city-dwellers' health; it responds to a very deep psychological need, the need to symbolize our reactions of freedom or aggressivity which the concentration of human masses in a completely artificial space can no longer satisfy.

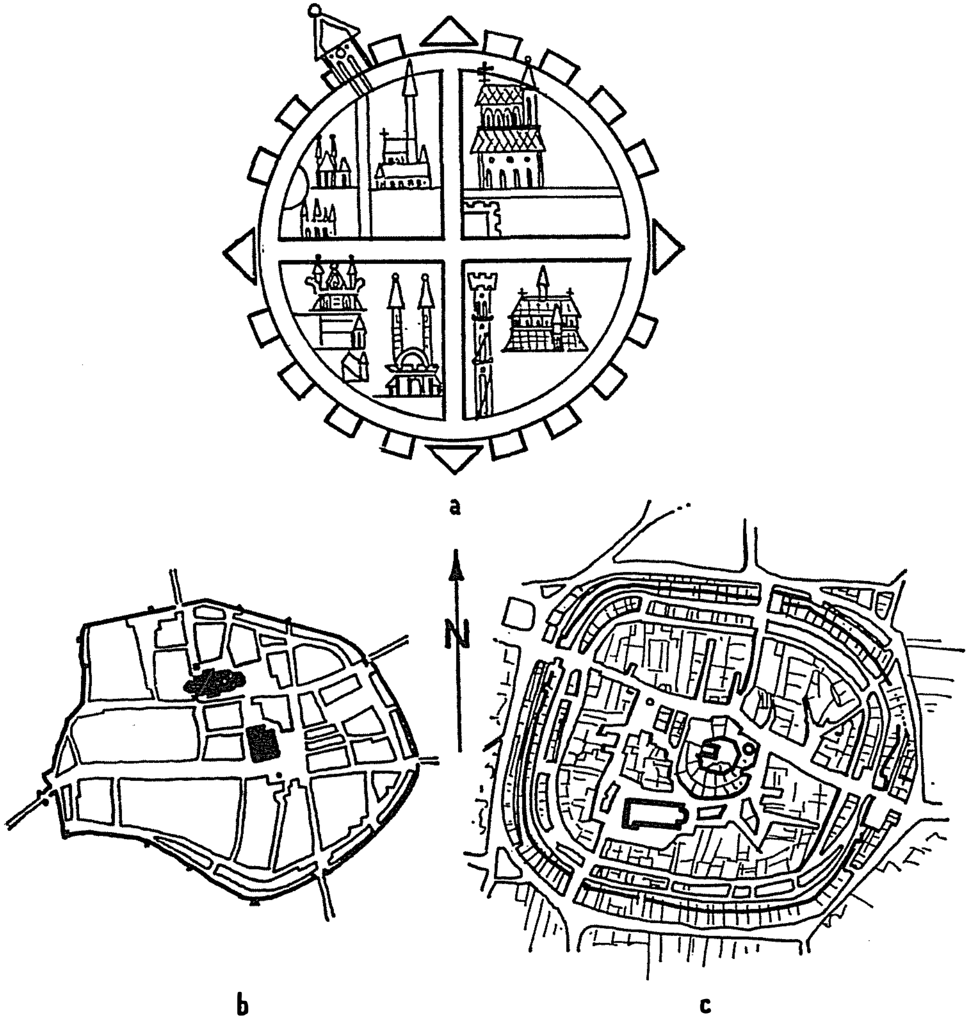


122. Plan of Prinias showing the emplacement of the Hellenic city, geometrical and oriented at the foot of a barred spur forming a fortified acropolis.

It is not by chance that systems of explaining the world belong simultaneously to religion and science. The reason why these two have been seen as rivals since ancient days is that they express, at two different levels, the same fundamental attitude of dynamic balance between safety and freedom. Each holds out a twofold promise, that of material or metaphysical assurance and that of convincing exploration. In prescientific times both aspects flowed into one within the former; the microcosmic configuration of the human city was perceived as tangible evidence of metaphysical reality. At the scientific stage the separation is merely apparent; individuals whose integration is incomplete, when they do not turn to science for a metaphysical demonstration of an immaterial reality, more or less consciously expect metaphysics to furnish them with material assurance of the reality of another world, which is still perceived as being located in the sky. The opposition of safety to freedom is also that of order to chaos, which is not disorder but the promise of effective organization: It is the opposition of the rhythmicity of daily actions to an escape into exceptional ones—the very foundation of the economics of progress which presupposes that a routine broken up by innovations is the basis for survival. By successive stages, from the highest to the lowest, we arrive at the same alternative, the same two-way flow or the same cycle that joins immobility to movement, safety to freedom, comfort to acquisition, the shelter to the territory. Upon these values human development constructs successive systems of symbols which, although increasingly complex, have a common origin.

The Middle Ages

It is interesting to note that the Middle Ages saw a major change in the form of the city. Mediterranean traditions had resulted in a geometric layout applied to the terrain more or less without regard to its topography. The foundations were laid in a cosmogonically significant oriented checkerboard pattern, but it was architectural volume that *made* the city. Thus the Roman city or encampment was from the very start an example of completely humanized form. European medieval traditions are different in nature, having developed from the elementary agricultural habitat—from the village whose houses are huddled together within a rounded enclosure that itself hugs the shape of a promontory or a hill. Orientation is observed, and the medieval city, like those of Mesopotamia or of the Aztecs, is coupled to the sky by means of two cross streets laid out in the direction of the points of the compass (figure 123). The sanctuary is situated at or near the central intersection and a cross, or sometimes a black stone, marks the ideal center of the urban space. The church itself is oriented



123. (a) Ideal plan of Jerusalem after a thirteenth-century Icelandic manuscript. (b) and (c) Plans of the medieval cities of Rothenburg and Egisheim. Note the persistence of cruciform street patterns in a circular area with a nongeometric layout. The main axis has been displaced because the directional church stands aside from the main streets.

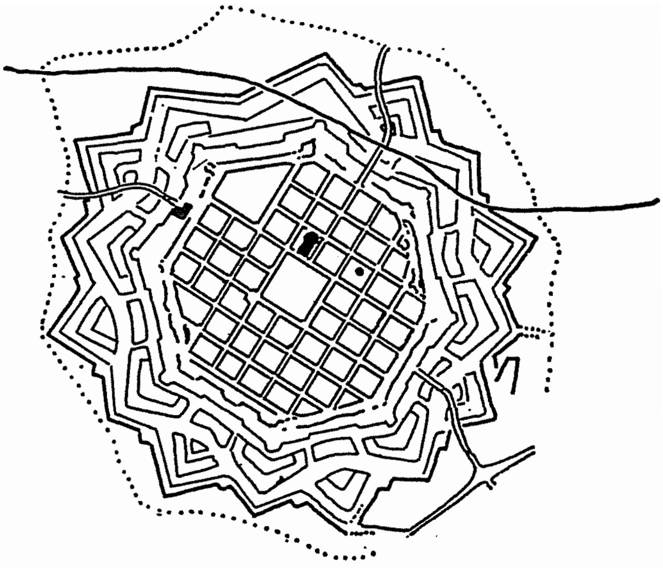
and its spatial integration fits into the traditional ground plan. The ideological content is different from that of antiquity. The symbolism of the cross informs the humanized space, but the underlying schema is the same and extends to the whole of the known universe. Jerusalem, a circular cruciform city, is situated at the center of a circular world cut crosswise by four seas, with four cardinal winds and with the heavenly bodies rotating round it. Every city is circular, at least ideally, and cut across by its four cardinal streets. The medieval cartographers' Jerusalem enclosed Calvary within its space, just as Mesopotamian temples had enclosed the ziggurat and pre-Colombian cities the pyramid. One of the urban microcosm's permanent functions, besides that of providing a link with the cardinal points, is to connect the center with the sky. In Christian ideology the connection is purely mystical, but the place of Christ's ascent to Heaven and descent into Hell corresponds to the center of the Christian world.

The consistency of the image of the world from the earliest cities until the Middle Ages, the frequency with which it recurs in different parts of the world and at different moments in history, suggest that what is involved is a basic trait of human behavior, as characteristic as manual activity or language. Integration in the cosmos, though relegated over the centuries to contexts increasingly far removed from the elemental, remains intact as a human need. From the earliest dawn of humankind until our Middle Ages it expressed itself in a religious cosmogonic vision. In modern times it reappears in the cold light of science.

The Eighteenth Century

With the Renaissance the Gothic schema was abandoned and ties were re-established, in appearance at least, with the classical past. Architecture recovered its long perspectives, and town planners sought inspiration in antiquity. The effect of this development upon the layout of our older capitals is difficult to trace. In many of them, like Paris, the circles of the medieval city are superimposed upon a still perceptible Roman ground plan, with neoclassical urbanism merely adding a few broad esplanades. But the integration of space in newly created towns, generally fortified ones like Neuf-Brisach or Brouage, is very characteristic. The indented fortifications dictated by the demands of artillery enclose a space rigorously divided on an East–West, North–South pattern with geometrically laid out streets (figure 124).

The building of new capitals such as Washington and Saint Petersburg in the eighteenth century marked the peak of an urbanism undoubtedly reminiscent of antiquity but, above all, dominated by the search for a rational balance of space



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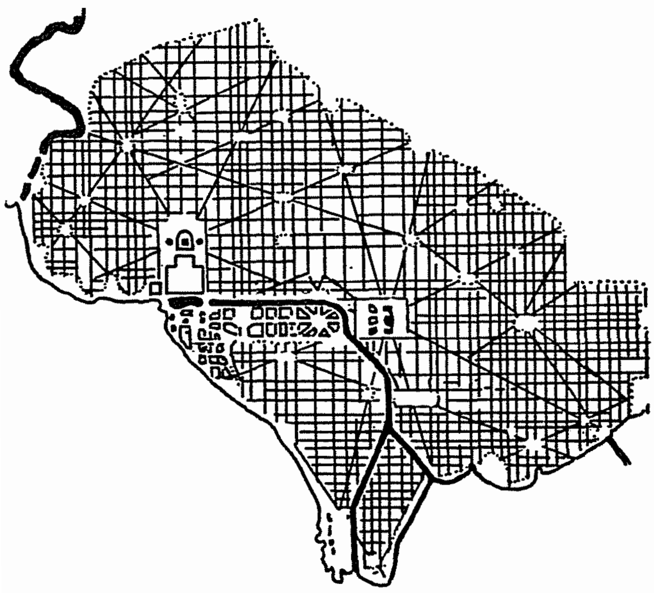

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124. (a) Plan of Neuf-Brisach, department of Haut Rhin, France, a seventeenth-century fortified town. The city walls are geometric as an artillery defense measure. The town has no orientation, but the traditional layout has been respected. (b) Eighteenth-century plan of Washington, DC. Note the double welt (cardinal and diagonal) and the disappearance of the cruciform layout.

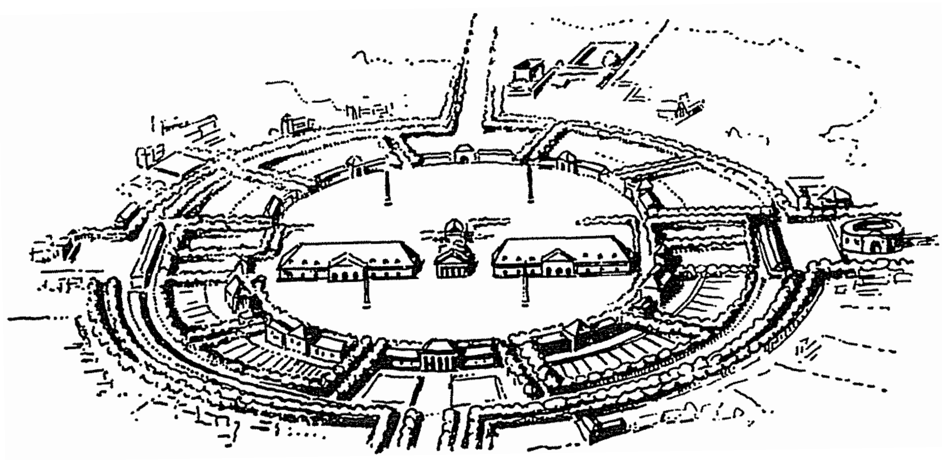
humanized by construction. No metaphysical concerns are discernible in Pierre L'Enfant's plans for Washington or Jean Baptiste Leblond's for Saint Petersburg, whose orientation is dictated only by the nature of the terrain and by a systematic humanization which, precisely as in the earlier instances we have discussed, leads to the establishment of a geometric network of main streets with right-angled intersections. At the dawn of industrial civilization, spatial integration was still conceived of as the antithesis to the untamed universe—that is to say, as an intransigent order to be imposed upon the chaos of nature.

It was an order that did not entirely escape from the principles of cosmogony. The eighteenth century was so steeped in ideas of comparison between religions, so fascinated with the search for a metaphysics of nature, that some sort of "neocosmogonism" was bound to emerge. It reached its peak in the work of the architect Claude Ledoux, who dreamed of urban developments ordered like the solar system. His plans for a "canon forge" or for the saltworks at Chaux (partially executed) anticipate present-day industrial urbanism using means of symbolic expression not even dreamed of by the emperors of ancient China (figure 125). But when all is said and done, these projects once more reduced urban space to a geometrically patterned area dominated by circular or quadrangular elements and situated at the intersection of four major arteries.

The Disintegration of the City

From the late eighteenth century onward, the character of spatial integration became confused. The effects of industrialization greatly accelerated the humanization of land space. The natural universe was crisscrossed by a network of railways and roads that determined a specific mode of growth (figure 80) comparable to that of microorganisms invading a tissue. The city became an "agglomeration" of utilitarian buildings, with connecting arteries provided as the need arose. Vast inhumanly humanized areas came into being, the individuals inside them exposed to the twofold effect of these cities' technical and spatial disintegration. The two chief imperatives of human well-being—creative activity, on the one hand, social and spatial integration, on the other—seemed completely to escape the control of a century beset by social crises. This anarchic development is still going on today, and its consequences are still felt in many city centers.

At no time in history has the link between acquisition and spatial integration perhaps been more clearly apparent than during the past century and a half. The human animal's venturing forth from its refuge in order to take cognizance of the



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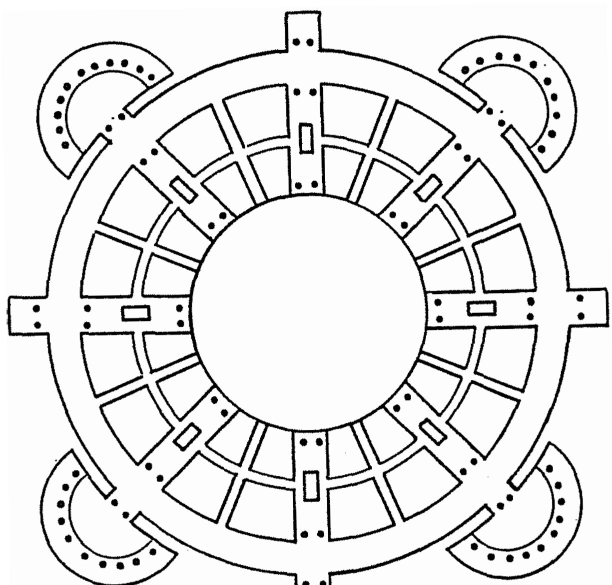

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125. (a) Isometric projection of the saltworks at Chaux, France, designed in the eighteenth century by Claude Ledoux. (b) Ledoux's plan for a cemetery at Chaux inspired by cosmic symbolism.

outside world is biologically connected with domination, victorious possession, annihilation of the consumable or simply destructible Other. Living in space and consuming in order to survive are one and the same thing. That is why it is so difficult to distinguish between symbols of birth and death in Paleolithic art, where the spear merges into one with symbols of virility and the mortal wound is indistinguishable from the female sex organ. In the course of his world-organizing travels, the hero of preagricultural myth in America or the Orient does not merely name rivers and mountains: He kills, and thereby immobilizes, the monsters who *are* rivers and mountains. The ideally cosmogonic city of the Mediterranean of proto-historical times and Antiquity was not merely an image of the universe, it was also the starting point for quests in search of domination and the place where precious metals and bronze were processed. The spatial conquest of the West, from the discovery of America to the assimilation of the last unexplored square mile, conducted in the name of the acquisition of gold and furs, spelled the death of the primitive human and animal world. If the rules of spatial integration that govern the forms of urban architecture and the functions of its various parts could be completely separated from urban architecture itself, aesthetics would be seen to play a rather minor role in the relationship.

Until the nineteenth century the forms of urban units—both large and small—were well-balanced even where their texture had been rendered highly complex by growth. The fact that balance of form could be maintained was largely due to urban distances, which from the earliest times had been adapted to the pace of walking. Eighteenth-century towns were still microcosms within which the individual dimension was respected in both space and time. Even eighteenth-century capitals were aggregates of parochial microcosms whose design was perceptible at walking speed, whether on foot or on horseback. Encircled by their walls or their boulevards, these cities could still be physically *felt* by their inhabitants.

The nineteenth-century agglomerations and the urban monstrosities that still survive (figures 80, 81, and 126) in the midst of our century's population explosion were the expression of a crisis undoubtedly caused by fundamental changes in social and economic values but actually touched off by factors relating to transport. For almost a century, while traditional urban centers and new industrial ones were rapidly becoming linked by railway networks, masses of people were still going about their lives at walking speed. The most important upheaval in the human adventure—the development whereby humans acceded to an *individually planetary mode* of spatial integration—has taken place within the space of five or six generations and is of such an order that its effects are still not felt by the majority of human beings.

126. Fez, Morocco, where some evolution toward a relatively geometric plan is discernible in the haphazard agglomeration of the Arab, Jewish, and European settlements.

Since the midnineteenth century, society's technical apparatus has adopted a scale of distances out of proportion with the orbit within which humans had always found their functional balance. The radius of the Magdalenian's hunting grounds, the area over which the farmer's fields are scattered, the rural baker's, or letter carrier's rounds, the urban shopkeeper's delivery area, all these are zones of personal gravitation measured by the rhythm of walking on foot or on horseback. From the midnineteenth to the second third of the twentieth century such zones have become increasingly disproportionate to the dimensions of the universe of railways, the telegraph, and the telephone. In a constantly expanding urban environment, individuals are gradually having to trace their own personal orbits upon a topographical ground that is consistent with the new means of communication but anarchic in relation to the space and time behavior of the zoological human.

Livable space is an ordered space whose limits we can encompass within a period of time compatible with the rotation of our daily activities. It is also a space that meets certain fundamental aesthetic requirements, one in which the humanized area stands in a certain ratio to the sky and nature. Ever since humans erected the first shelter in the middle of their territory, humankind has lived in a state of balance between the artificial and symbolic universe and the sources of material and mental energy found in the material world. A transposition of the natural into the artificially constructed, such as a garden city, is perfectly conceivable: But our formless city lacking any semblance of logic, with its girdle of factories and its grid of utilitarian streets under a sky of toxic filth, can only be regarded as the result of pathological disturbance. That efficient tool of social production, the nineteenth-century city—still alive in most parts of the world—represents an alarming break with the laws of biological harmony upon which our humanness is surely founded.

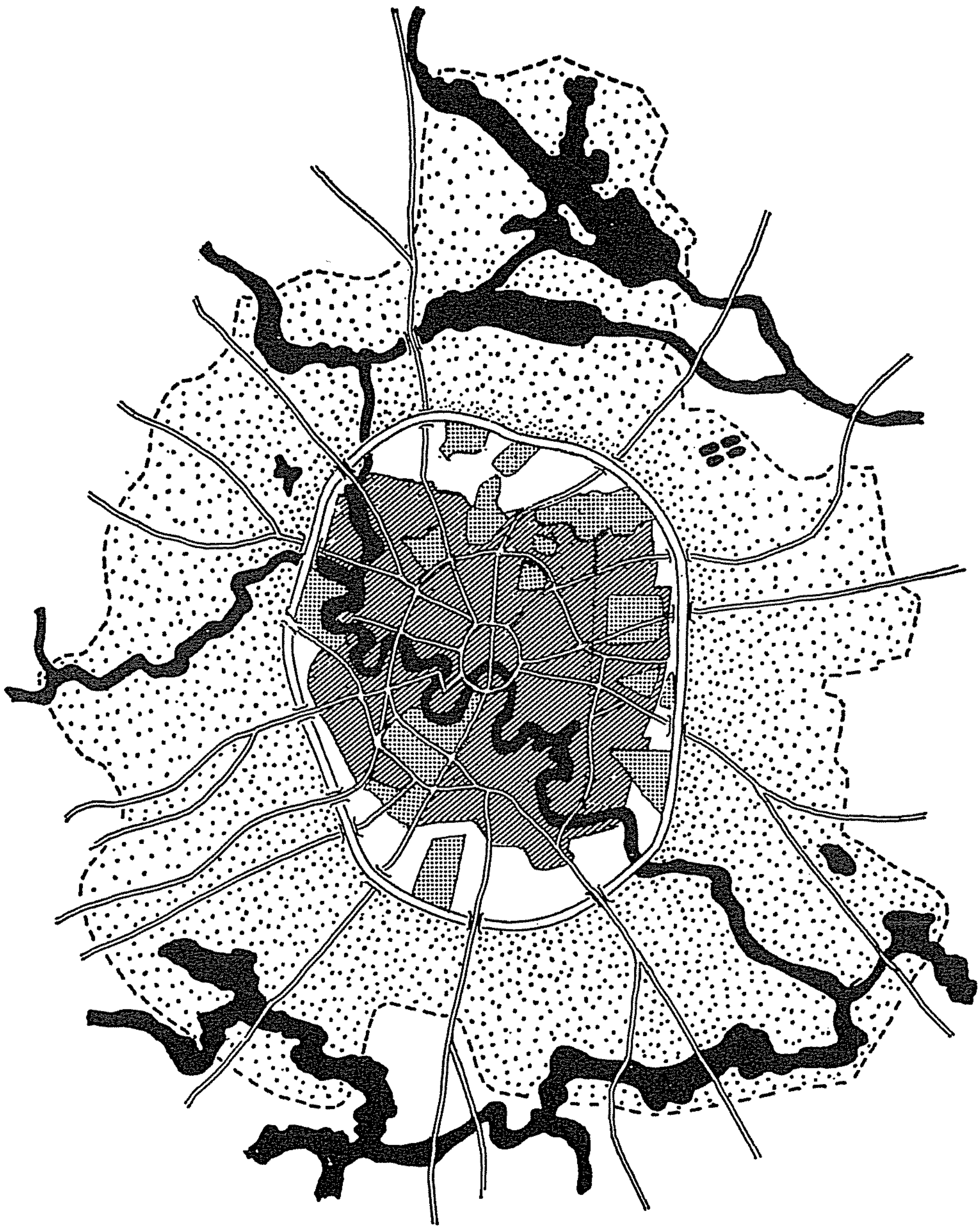
The Present-day City

The ideal formula for the individual's satisfactory integration in the urban microcosm of today is simple and has been found empirically by many city planners: Each family unit provided with an autonomous shelter at the center of a personal territory constituted by a piece of nature—wild or domesticated—with individual means of transport capable of bringing the "hunting ground," or workplace, within reach as rapidly as before the transport revolution. This formula, conceivable below a certain population level, has become inapplicable except for the most privileged families anywhere in the world, and city planners have had to resort to a crude transposition by providing cellular dwellings in blocks of flats set inside a border of lawn within reach of a bus stop.

Present-day urbanism undoubtedly has the capacity needed for the reconstitution of a balanced universe, and in places where the insoluble problem of housing an exponentially growing mass of people does not arise too acutely city planners have actually been known to hit upon new ways of meeting the biological imperatives of integration in time and space. Up to a certain threshold, the town with its central monuments, its museums, parks, and zoological gardens, continues to be a cosmic reflection of the universe—a reflection that in turn reflected in the names of the town's streets and hotels invoking neighboring provinces and friendly or conquered lands. Roads leading out of the city are called "North" or "South," railway stations are named after starting points in the network within which the accessible universe is enclosed. There is no radical difference between the Babylonian city and a modern capital, for it is not gratuitous intellectual refinement that makes a city into the image of the world (figure 127).

The Argentinian, Siberian, and Polynesian suburbs of the future capital of Earth will doubtless be crossed by avenues named after Mars, Sirius, and Alpha Centaur. We may be sure that a schematic picture of the human universe by time sectors will be preserved in its archaeological museums. A place will be found in them for all the precious remains of the integration in time of previous generations, from Pithecanthropus to the twentieth-century television set. And zoo directors will exchange among themselves the newborn members of a population of elephants, crocodiles, and Normandy cows which will exist only behind the bars of cages protecting them from the human masses uniformly spread over the earth's surface.

At this stage the basic data of spatiotemporal integration will not have changed; the same assemblage of animal, vegetable, and human, though in different proportions, will doubtless continue to ensure the individual's links with the universe. Integration will be all the more total as, seated in their armchairs dozens of miles from the nearest scrap of real nature, millions of human beings will at the same moment experience the same passive escape into the depths of a tropical forest projected on a screen in its true colors, sounds, relief, and odors. The point may be reached when superhumanized space will contain only such samples of nature as are necessary in order to maintain within the human mass, by audiovisual techniques, outside of any kind of lived reality, a perception of a human connection with the universe from which remote human ancestors drew their reason for being and doing.



127. Diagrammatic plan of present-day Moscow showing an attempt to establish a system radiating concentrically around the Kremlin and surrounded by a green belt.

The Symbols of Society

The spatiotemporal system in which we have imprisoned the natural universe is, as we have seen, directly connected with the most fundamental fact of biological existence, that of integration in an environment in which and on which the individual has to survive. At the technoeconomic level the nature of human integration is no different from that of animals having territories and shelters. It is quite otherwise at the aesthetic level, integration being based on purely symbolic references accepted by society under a rhythmic convention that puts days and distances within an artificial network. The separation between free time and space, on the one hand, and domestic time and space, on the other, remained reasonably wide until quite recently, except in urban environments where a completely humanized framework was always a token of the efficiency of the city's apparatus. The infiltration of urban time has taken place within a few decades, initially affecting only long intervals of time through the regularly periodic character of transport facilities but now spreading to all moments of the day to suit the rhythm of radio and television broadcasts. A superhumanized space and time would correspond to the ideally synchronous functioning of all individuals, each specialized in his or her own function and space. Human society would, through spatiotemporal symbolism, recover the organization of the most perfect animal societies, those in which the individual exists only as a cell. Because of the development of its body and brain, through the exteriorization of tools and of the memory, the human species seemed to have escaped the fate of the polyparium or the ant. But freedom of the individual may only be a stage; the domestication of time and space may entail the total subjugation of every particle of the supraindividual organism.

The space-time system is only one of the elements of the social fabric. It does not involve relationships of individual identification. In all living systems beyond a certain degree of functional complexity, cohesion of the group is ensured by a system of interindividual references. This system, well-developed among mammals and birds, includes bodily, visual, or olfactory signals, attitudes of submission or superiority, and vocal signals. In these three forms, or with one form predominant over the others, the system governs the relations between the sexes, between the young and adults, and between competing males, as well as the gregarious behavior of herds. Together with territorial integration, it organizes most of intraspecies existence, and it covers almost all behavior that does not strictly pertain to the acquisition of food. The most extraordinary activities of birds are deployed in their mating finery, displays and nuptial dances, and in their song which has as much to do with pair forming as with the organizing of territory, with defense, and with relationships between individuals of the same species. Mammals show considerable range and flexibility in their attitudes, mimicry, tail movements, and vocal signals, and the higher species, carnivores or primates, have a whole gamut of expressions that not only normalize intraspecies relationships but also constitute a highly efficient code of interspecies communication. This code of signals of prohibition, submission, or sympathy leads to the establishment of a hierarchy among the component parts of various social situations within the species or between different species. Within the human species the problem is not very different. The set of elementary signals is the same and performs the same role, that of normalizing the relationships of individuals within the same ethnic group who are of different sex or have a different material or moral potential. The gestures and mimicries that express simple feelings of satisfaction or dissatisfaction, or domination or submission, belong to a code which the human shares with a part of the animal world, though their variety is greater, as might be expected in view of the more complex human organization. But—as is normal for the human—this code underlies an extremely dense symbolic superstructure. Like tools, it is exteriorized in a system of references that relates to the ethnic group, not the species, and that expresses itself in dress, bearing, language, and the social setting.

Dress

The protective value of the animal's pelt or plumage is not more important to the survival of the species than are the visual or olfactory signals attached to them. In humans the protective value of clothing is equaled by its form; it is clothing and its decorative accessories that provide the basis for the first degree of social recognition. Imagine, within our own code, a man wearing spurs with espadrilles, a priest's cassock, and a flowered straw hat: The rigid nature of our system of references would be revealed by such a person's prompt withdrawal from social circulation! Every individual, male or female, though all are clad in a three-piece suit or a dress, sports a certain number of precise indications of social status—color of tie, type of shoes, quality of the cloth, floral buttonhole, or perfume. And what is true of our society is just as true in Melanesia, in China, or among the Eskimos.

The value of dress is primarily ethnic: It proclaims the individual's membership in a group. For a century the wearing of European clothes has symbolized advancement toward civilization, the assumption of an ideally human social persona. Conversely, the last scraps of the feeling of integrally belonging to a group cling to folk costume, vestige of the distinctive garb once worn by the inhabitants of a recognizable area.

The function of clothing and of its adornment relates to many aspects of social organization. Exactly as among birds, it consists in announcing the wearer's ethnic group and, at the same time, his or her sex. Simultaneous identification determines the register of the relationship: A meeting with strange men involves the relationship between dominator and dominated; a meeting with male or female relatives sets off affective reactions according to the standard applied within the group. Whether in the case of Papuans on a journey or of two modern armies facing each other, relationships begin with identification of clothing or of weapons. It may seem pointless to stress so commonplace an aspect of human existence, but the aesthetics of clothing and adornment, despite its wholly artificial character, is one of the biological traits of the human species most profoundly linked to the zoological world. Morality systems notwithstanding, anything that touches upon aggressive or reproductive behavior must naturally stay close to the source. Such discontinuity as there is will be found only in the human ability to develop new symbols of fear or allurement, to bring to the art of killing or of loving—those two central pivots of history—an intellectual finesse peculiar to our species.

Dress everywhere is conditioned by war, love, and the individual's position in the social hierarchy. By adding the distinctive signs of each age group, we obtain a classification grid that tells us all we need to know about the social function of costume. The age-group factor is not a constant one; only some societies possess an explicit or implicit code of clothing for separate age groups. In Japan, for example, feminine costume shows a strict progression according to age as regards the length of sleeves, the size of the flowers in floral patterns, or the brightness of colors. Similar conventions exist in traditional European society. The progression is further accentuated by fashion; the dress of old people may be symbolic of their age group and at the same time morphologically archaic, one or the other of these elements being predominant depending on the society and the individual concerned.

Besides the symbols of sex and age, there are those of social status. In primitive as well as all other societies, these relate, first, to the major stages of life—initiation, marriage, the widowed state. They also refer to the individual's technoeconomic status, offering an infinite variety of costumes and adornments of warriors of different rank, chieftains, merchants, artisans, and all other representatives of the mosaic of functions upon which the material life of the group is founded.

At the stage of development of European societies a century ago—less in the case of other societies with agricultural-pastoral economies—all individuals, male and female, wore on their bodies the means of their identification for purposes of establishing contact and making appropriate use of language and gesture in accordance with the relationships between different categories within the group. The traditional symbolic equipment has been considerably modified by industrial technoeconomic development. Thanks to an ideological evolution assisted by the mass media, social permeability has increased while the number of social models has diminished, with European dress symbols tending to replace regional ones all over the world. Loss of national and craft costume is the most striking sign of ethnic disintegration. Far from being a minor accident in the course of a major process of adaptation to new conditions, it is itself one of the main conditions of adaptation and one that often precedes full adaptation by more than a generation. In Africa the European intellectual's eyeglasses were a symbol of development long before the model's scientific level was reached, and there are countries where the necktie came in before the shirt.

Dress, truly the symbol of humanness, is a precise measure of ethnic and social organization, and what is happening to dress at present deserves careful attention. In Europe and America the standardization of dress has reached an advanced stage; masculine and feminine costume hardly varies from one social class to another except by its greater or lesser costliness and the immediacy of its adaptation to fashion. This may denote across-the-board social advancement, the disappearance of social barriers, and higher levels of culture and information, but it is also a sign that the individual is losing his or her links with the framework of the group within which he or she is personally integrated. Living in the costume of your province or craft makes you feel that you are an individual element of your own group and, at the same time, reminds you that you do not belong to other groups. Living in a standardized human uniform implies a high degree of interchangeability of individuals as parts of the universal macroorganism. The standardization of dress symbols may mean acquiring a planetary consciousness, but it also means losing the relative independence of your ethnic persona. The disappearance of carnival disguises is another symptom of the same development. We may, depending on where we stand, be alarmed because the individual is losing the signs of his or her reality as a member of a society on a human scale or welcome the fact that humankind is being reduced to a single type of human ideally suited to the sole function of serving as a production cell: No matter, the fact remains that the development of the symbolism of dress reflects the transition to a humanity different from the one still remembered by living generations.

Vestimentary models persist in fiction; the press, television, and films seek to make up for the individual's loss by briefly enabling the spectator to dress up in his or her imagination as the hero or heroine. As in all areas of the imagination today, the number of models is limited and monotonous: A Sioux Indian, a cowboy, a musketeer, an ancient warrior of indeterminate origin, a soldier from our own latest war, and an astronaut just about exhaust our stock of aggressive symbols; then we have the bespectacled scientist in a white coat, the financial mogul, the gangster, the femme fatale, a few Tibetans, some uniformed Asians, a detective, and a handful of "savages" adorned with feathers. The register of sentimental literature is naturally somewhat different, although it borrows a few of the symbols just listed. Its favorite costumes are those of the nobility of recent centuries, the society of high finance, reigning families, Oriental princesses, and film stars. The permanent process of exteriorization would seem to operate here as in all other fields: Instead of actively playing the hero's role in some ethnic adventure, the human now satisfies a natural need to belong by watching the performances of a few conventional stand-ins.

From being a biologically determined feature, identification symbols thus tend to become interchangeable and strictly intellectual instruments. They survive in their earlier form only in certain narrow environments and under exceptional circumstances: state occasions, law courts, academic ceremonies, horse races, sports. The wedding dress still has a certain vitality, but symbols of initiation, such as first-communion dresses, and symbols of mourning are disappearing fast. At the end of the universal planing-down process, the mass of individuals are left only with professional uniforms—essential elements of the mechanic's or the deep-sea diver's economic efficiency—and the stubborn vestiges of marriage costume.

No mention has yet been made of religious costume. This has two mutually opposed aspects. The first is the normal one of the social status symbol: In all religions, religious vestments are designed to convey the most solemn possible image of the officiating cleric's function. The Siberian shaman's, African dancer's, Buddhist monk's, or Roman Catholic priest's costume has as much to do with figurative representation as with social aesthetics: Like the costume of a civil or military chief, it forms part of a setting and has only incomplete meaning in isolation. The other aspect involves the personal identification symbols that distinguish the clergy from the laity.

The ordinary dress of lay people is subject to constant changes of detail which in all civilizations mark the passage from one generation to another and which constitute fashion. Often this process affects the general structure of clothing only very slowly (the main items of our costume have hardly varied in a century), but because of its direct connection with sexual attraction it forms an area of strong competition and produces innumerable variants, its rate of development being continually renewed by the sexual maturing of fresh groups of individuals. As in the zoological world, fashion in clothing remains linked to the meteorological seasons and is subject to annual renewal.

Professional costume develops in accordance with an entirely different rhythm. It does not follow the general fashion too closely and may continue unchanged for several generations if the function remains constant. The warrior's costume develops at the rate of successive wars and always shows a certain conservatism, further reinforced by traditions of prestige. In institutional dress this conservatism is still more pronounced; the dress of public dignitaries, diplomats, and legal and academic authorities is always at least a century behind that of the rest of the population. Major political upheavals generally lead to a renewal of certain parts of the official wardrobe and fairly often to the creation of new items that are, however, always reminiscent of the past for prestige reasons.

Because religion claims to be stronger than time, tradition is all-powerful in religious costume which should ideally be invariable so as to convey majesty and permanence. In practice, religious costume worn for purposes of personal identification is exposed to the delayed influence of lay fashions, undergoing either changes of detail or abrupt major transformations followed by long periods of stability. Ceremonial costume is far more conservative, with centuries-old forms surviving in Roman Catholicism, Buddhism, and Shintoism alike.

The most interesting aspect of religious dress is a negative one. As we saw earlier, individual enfranchisement—breaking out of the circle of social operations—is achieved by rhythm-controlling techniques: control of physiological rhythms through ascetic practices and of normal operating rhythms through practices regulated by a strict and invariable timetable. Social identification is controlled by refusing to accept the symbols of sexual and hierarchical recognition. The ascetic goes naked or almost naked, or else he dresses in defiance of convention, the fabric, form, or color of his clothes placing him outside the code of technoeconomic assimilation. Just as he defies time by staying awake and fasting and defies space by living in the desert, in a cell, or in the dust of a city crossroads, so by refusing to adopt the dress code of socially organized humanity he defies social classification. Religious morality being, at its extreme, a morality of individual liberation, unlike social morality which is based upon collective commitments, its symbols are normally the reverse of those of society. To a different and variable degree, attempts to break out of the standardized social pattern entail the adoption of special symbols, which may be individual like the extravagant garments sported by artists or collective like the black leather jacket of the young men of today.

Attitudes and Language

Although clothing is in itself sufficient to ensure recognition and orient subsequent behavior, it cannot in normal practice be dissociated from attitudes and language which serve to supplement recognition and organize responsive behavior. Besides clothing, travelers in the past were interested above all in social attitudes and forms of politeness. Most descriptions we find in the earliest works of ethnography are devoted to costume, ways of greeting, conduct during meals, or manners toward social superiors or inferiors. Eighteenth-century descriptions of strange peoples, like the same period's writings on natural history, were based on external identification and on very general lines of responsive behavior. The reason is that knowledge generally stopped at the outer shell within which the real life of groups takes place. This makes it all the clearer, however, that among the Chukchis or the Tupinambas, manners come second only to clothing as a means of identification both within and outside the group.

Attitudes and language of responsiveness are situated at the limits of the sphere of figurative representation. Members of the group engage in a nonstop performance of their own ethnic drama through the rhythms of social life, through social space, attitudes, and status symbols. The whole of ethnic life is a matter of figurative representation, for the individual is incorporated in the group only to the extent that he or she dons the uniform of gestures, behavior patterns, and clothing symbols which identify his or her nature as *Homo sapiens* with a particular culture. The representational element becomes more and more pronounced in its progression from elementary, mechanical practices to exceptional ones, from technical to social and religious operations, culminating in ceremonial activities where the dividing line between the social and the figurative is extremely blurred.

In modern societies the separation between lived experience and figurative representation has become more clear-cut. We are unlikely to confuse a ball with a ballet or a mass with a performance of a passion play. In the great traditional festivals of the imperial courts of China or Japan, the distinction between civil or religious ceremonial, on the one hand, and theater or a sporting contest, on the other, is less easy to draw. In societies whose hierarchical systems do not provide for strict compartmentalization of the places for, and the participants in, social ceremonies and figurative representations, respectively, such separation becomes altogether impossible. When the actors are drawn from a crowd of courtiers, the temple or palace with its dignitaries, the stage and its actors flow together. In the ceremonies all participants—at whatever level—are alternately spectators and extras until, under the sheer weight of numbers, a passive group becomes separated from the mass and becomes a real "audience" of the spectacle: But even then there would be no spectacle without the "audience's" assistance.

Thus figurative representation in its most primitive form appears indissociable from the social events that maintain the ethnic group's continuity. From this aspect, the degree of figurative participation is consistent with the group's technoeconomic characteristics. Figurative specialization and the separation between actors and spectators are at a maximum in modern mass participation, where the majority of individuals are no longer required to perform as extras in social events but where all prestige occasions have been reduced by television to the status of pure spectacle. Conversely, where the carnival still exists, all participants may still sometimes fill both roles simultaneously.

In primitive or traditional societies, figurative behavior of a socioreligious nature includes all possible transitional stages between the role of the isolated individual, such as the shaman who enacts before a crowd his voyage in search of a sick person's soul, and the society of initiates offering the highly elaborate spectacle of its dances, or a whole Australian tribe acting out its myth.

Figurative behavior is so deeply a part of human nature that it is difficult to adopt a systematic view without losing sight of its reality. The difficulty appears to lie in the fact that social figurative representation also has extremely solid roots in zoology. The humanness of attitudes and insignia is not a matter of their nature but of their connection with ethnic specificity. Since the days when Buffon described the dances of Numidian cranes, zoological research has revealed a multitude of facts showing that bodily attitudes and insignia dominate the relationship behavior of birds and mammals in terms both of the hierarchy of individuals and of relations between members of the two sexes. Most social relationships are connected with those two complementary aspects of biological behavior. The relationship between dominator and dominated and nuptial displays, or relationships of prestige and relationships of coquetry are, once again, the species and ethnic forms of the same phenomenon. In humans, there is the symbolic superstructure, but it really is a superstructure—in other words, there is no fundamental difference between the cock's comb and the plume on an officer's helmet, the cock's spur and the saber, the nightingale's song or the wooing pigeon's bowing and scraping and the village dance. But there are as many variations as there are ethnic groups in the world, successive generations within each ethnic group, and social categories within the group.

The various elements of social behavior—setting in space and time, dress, attitudes, and manners—form a whole whose parts develop, by categories, at rhythms that must be compatible with ethnic survival. The participation of all levels of the body social, from the individual to the group as a whole, in the evolutive process is a matter of functional balance. Systems designed to ensure religious or legal stability contain the greatest possible number of symbols of permanence. The buildings, vestments, and liturgical language of the great official religions are at least a thousand years old, bearing witness to the continuity both of the civilization concerned and of the divine order associated with it. Legal language dating two or three centuries back, employed in a setting filled with figurative symbols of strict balance by a depersonalized individual dressed in the traditional costume of the upholder of the law, gives courtroom events that element of continuity which is necessary in order to convey the sense that a socially vital obligation is being discharged. Conversely, in the sphere of procreation or, more broadly, of individual life, where collective survival is founded upon renewal, the individual derives his or her sense of belonging to a system from symbols flexible enough for each age group to recognize itself in its uniqueness.

Thus we see that the biological lines of the figurative grid that is peculiar to humans are common to all living beings. The striking fact about modern evolution is the loss of most of our social symbols. The disappearance of ethnic or professional costume and accessories, the impoverishment and uniformization of the language of responsiveness may be a commonplace, but we have so few development criteria to work with that we cannot afford to ignore such a break with the traditions which seemed best to circumscribe the social nature of the human being. One wonders whether the emergence of a universal type, if not perhaps in terms of language, then in terms of dress, gestures, and ways of speaking—a type originally based on the characteristics of well-to-do Europeans—is just a stage beyond which another diversification will take place or whether, on the contrary, the process will eventually lead to male and female characteristics too becoming ideally identical with one another for purposes of ideal interchangeability within the production process. The coming into being of a single megaethnic group with uniform components is not inconceivable—indeed it has been the explicit or implicit ideal of a number of philosophers and sociologists from ancient times—though it would doubtless have to be preceded by the emergence, taking several centuries, of a partial and antagonistic macroethnic group. This macro-ethnic ideal is already reflected in the Western, Russian, Chinese, and Arab worlds of today. Short of imagining that the idea of humanity may supplant that of mastery over the universe, one fails to see by what mechanism micro-ethnic individuality could be restored. Seen from this angle, the dilemma is between the individual as the motive force of a social microcosm built to human scale, a microcosm in which the individual commands the full gamut of aesthetic and technical possibilities, and the individual as a cog in the infinitely perfectible machine of a completely socialized society.

Obviously human development is heading in the direction of mega-ethnicity—a global unit of measurement rather like the "megadeaths" devised to express the destructive power of atomic weapons. We therefore might well ask ourselves what continuing means of escape the zoological flux will have at its disposal—for complete dehumanization would eventually become prejudicial to the efficacy of the social machine, and it must therefore be kept in a sufficiently "sapient" state. In other words, we may wonder whether yet another process of exteriorization—this time the exteriorization of social symbolism—might not be taking place. In fact the process is already so advanced that we can clearly see the direction it is taking. Artisanal methods are dying out in social life, as they are in crafts and war; the tendency toward exteriorization is felt to the same degree in all these fields, a fact that is reflected in the indirect handling of masses of material at an increasingly limited number of points. The time is not far off when all our manufactured iron will be processed in a small number of centers by entirely automatic methods; this has already happened in the case of oil, where the diversity of products is not great enough to hamper the development. We can see the time coming when government will no longer have to call upon the uncertain services of artillery, and the megadeaths will instead be processed indirectly from electronic control panels. This in fact is already feasible. As for the social sphere, modern audiovisual techniques, imperfect as they are, already provide a most convenient staging-post. The age we live in is still filled with survivals from the past. The city worker still goes out to watch a soccer game, catch a fish, or attend a parade, and still has a life of responsiveness, restricted it is true but one that may stretch to taking part in the activities of a club. If we exclude the vital cycle, activities involving direct response are increasingly confined to adolescence and the preconjugal period, when direct participation is necessary to collective survival. Until we get to the stage already reached by the species of domestic animals that are best suited to productivity—the stage of artificial insemination—it would, for the time being, seem that a modicum of social aesthetics will continue to surround our years of social maturing. In insect societies, by the way, that is the only period when the reproductive minority shows some independence of behavior.

Social Aesthetics and Figurative Life

Finally, we might wonder whether humankind has completely escaped the risk inherent in the perfection of the ants and the bees, that of practically complete social conditioning. The role of functional independence in human development has been sufficiently stressed in the preceding chapters. We know that the present stage was reached by gradually refining an apparatus that has remained open. It is not easy to judge the present point in the evolution of the human race, when many individuals are barely a generation away from the times of artisans, farm laborers, village weddings, bands of strolling players, a whole social setup whose traces have not yet disappeared from many parts of the globe. But the process of exteriorization becomes more and more accentuated as the years go by, and millions of individuals already living today represent something new for the ethnologist. A minimum of social practices exists in order to keep these individuals in day-to-day working order: An infrastructure takes care of their personal leisure, preconditioned by holidays with pay, roads, hotels, camping grounds, and anything else needed for a few weeks of "channeled freedom"; a light superstructure enables them to accomplish the rites of passage, be born, get married, die with the necessary modicum of emotion or spectacle. Their scope for personal creativity is smaller than a nineteenth-century washerwoman's, their entire productive function consists in clockwork precision—precision in waking, traveling, performing stopwatch-timed gestures at work. Were they indeed like this, the outlook for future generations might almost be a reassuring one, for the genetic impetus would be strong enough to resist dehumanization. But it seems that our destiny still lies in evolution. In actual fact the social participation is the same as that of our ancestors, indeed it has been considerably improved: Through the window of the television set, through the lips of the transistor radio, we can be present, not at a village ceremony, but at parties in the homes of the great, not at the wedding of the baker's daughter, but at those of princesses; the football teams we watch are the continent's very best, and we watch them from the very best seats. The snows of Canada, the sands of the desert, Papuan dances, the best jazz bands come to us through openings in magic boxes.

In chapter 6 we spoke of the problem of the relationship between language and audiovisual techniques. Here another aspect and another consequence of the same problem become apparent in the context of social operating sequences. Between the period now ended and the one just starting, the proportion of genuinely creative individuals to the mass of people has remained much the same; we may be sure that some will still sing with their own voice, take part personally in an important ceremony, kick a real leather ball with their own foot, or even cut the wood for their own chair from a real tree trunk. But such people are the exteriorized element of the social apparatus; their function consists in providing the multitudes with their necessary ration of social participation. As for the multitudes, no, they will not sing at weddings nor walk in torchlight processions; on their short walk to the bus stop they can already avoid direct contact with birdsong by turning up the volume of their transistor.

Isolated inside their micro-ethnicity, the group's members had to make their own shirts and construct their own social aesthetic as best they could, losing so much time in the process that the profit to the community as a whole was only slight. A considerable saving is obviously achieved in a system where the producing individual's life is divided between productive activity and passive reception of his or her share of community life, a share chosen, measured, prethought, and lived by others. Like the freeing from culinary art through canned food, freeing from social operations through television is a collective gain. The gain is offset by a risk of social hierarchization probably more pronounced than heretofore; a process of stratification by rational selection will skim off the rare elements in the mass of society and make of them the purveyors of remote-controlled adventure. An increasingly small minority will plan not only society's vital political, administrative, and technical programs but also its ration of emotions, its epic adventures, its image of a life which will have become totally figurative—for the transition from real social life to one that is purely figurative can take place quite smoothly. The first step was taken with the first hunter's tale told by a Palaeoanthropian, and with the first novel and the first traveler's tale the path widened. Our society's emotional ration is already largely made up of ethnographic accounts of groups that have ceased to exist—Sioux Indians, cannibals, sea pirates—forming the framework for responsiveness systems of great poverty and arbitrariness. One may wonder what the level of reality of these images will be when their creators are drawn from a fourth generation of people remote-controlled in their audiovisual contacts with a fictitious world. The imagination, which is nothing other than the ability to make something new out of lived experience, is in danger of declining appreciably. The mediocrity of our popular literature, illustrated magazines, radio, and television is an interesting pointer. It reflects a natural selection of authors and subjects, and we may assume that the statistical majority of consumers are getting the emotional food they need and can assimilate. But our world lives on a capital of survivors with which it may be able to recapture some degree of lived reality. Ten generations from now a writer selected to produce social fiction will probably be sent on a "renaturation" course in a park a corner of which he or she will have to till with a plough copied from a museum exhibit and pulled by a horse borrowed from a zoo. He or she will cook and eat the family meal at the family table, organize neighborhood visits, enact a wedding, sell cabbages from a market stall to other participants in the same course, and learn anew how to relate the ancient writings of Gustave Flaubert to the meagerly reconstituted reality, after which this person will no doubt be capable of submitting a batch of freshened-up emotions to the broadcasting authorities.

Such an outlook might be thought exaggerated and overpessimistic. But it represents an aspect of development that does not seem so far to have attracted much attention. In the most optimistic scenario the problems of manual work will have been resolved within a few generations and war and political divisions will be a thing of the past, which means that our humble physical adventure will be over and the reasons for maintaining an epic ideology will have gone. The earth will be densely peopled by healthy, well-fed human beings actively employed in ensuring the survival of a definitively stabilized mass. The seas, forests, and mountains will offer no more adventures except by way of accident. The twofold obsession of our popular press with the love affairs of royalty and film stars, on the one hand, and with disasters, on the other, is symptomatic in this respect. If we transpose the present situation into a pacified world peopled by men and women identical in their way of life and their tastes, we are left with a sense of emptiness as regards one of the specific attributes of *Homo sapiens,* the capacity of the body, hand, and brain to exercise the individual privilege of material and symbolic creation. Neither the Teilhardian nor the atomic apocalypse provides a solution, for both may be deferred to a geological future, whereas the human race may very soon be confronted, not only with the problem of its demographical balance, but also with that of its rehumanization.

14 The Language of Forms

Figurative behavior cannot be dissociated from language: It forms part of the same human aptitude, that of reflecting reality in verbal or gestural symbols or in material form as figures. Just as the emergence of language is connected with that of hand tools, figurative representation cannot be separated from the common source from which all making and all representation spring. Therefore we should not be surprised to discover a close parallelism in paleontological development and, in particular, to note a swift and profound change in materials at the moment *Homo sapiens* emerges from the last Palaeoanthropian stage.

It is not easy to arrive at a formal definition of figurative behavior, for while the difference between theater and painting or easel painting and wallpaper is perfectly clear to us today, the distinctions become blurred when we attempt to deal with earlier periods or with different ethnic forms. Earlier we saw the profoundly figurative character of social aesthetics: ceremonial and theater are not categorically distinct from each other, and events represented in stage decors or temple frescoes may be either mythological or historical.

Neither is it an easy matter to formulate a hypothesis about the precise moment in the life of a society at which ceremonial as lived experience becomes theatrical representation or when figurative representation perceived as essential to life becomes pure decoration. At an Australian corroboree, with its costumes and props and its episodes in which dancers mime a mythical animal's behavior, ceremonial and drama are not distinct from each other; the Upper Paleolithic, with its art known to us through thousands of records, offers equally good examples of figurative representation on walls or slabs as of utilitarian objects embellished with decorative motifs. The same lack of differentiation is characteristic of all primitive peoples today and at the very beginning of the existence of *Homo sapiens*. To discover the point of divergence between the religious, the social, and the dramatic, it is surely not enough—except perhaps in the realm of fiction—to go back in time and along the scale of technoeconomic hierarchies; in the real life of all societies, different forms coexist and merge imperceptibly into one another. Whether one is talking about a sacrificial rite, a political address, or a play, the relationship between the individual performing the representation and the matter being represented is less important than the values that the performer and the audience hold in common, for these values make it possible to graft an aesthetic apparatus attuned to the appropriate emotions upon an operating sequence of a religious or social nature. It is this emotional language, some of whose values have a very general biological origin but whose code of symbols is highly specific, that really constitutes figurative art.

All art then is utilitarian: the scepter, symbol of royal power, the bishop's crook, the love song, the patriotic anthem, the statue in which the power of the gods is cast in material form, the fresco that reminds churchgoers of the horrors of Hell, all undeniably meet a practical necessity. The gratuitousness of art does not lie in its motivation but in the flowering of the language of forms. It was an astonishing aberration on the part of late-nineteenth-century prehistorians confronted with Paleolithic works to invent the theory of an original "art for art's sake": In reality Lascaux was no less part of the social and religious life of its contemporaries than the Sistine Chapel was of sixteenth-century Rome. Like the language of words, that of forms may or may not be rich or eloquent, but its fundamental purpose is to signify. An art that has lost its purpose is antithetical. The antithesis is justifiable as a means of escape from the excessive power of the imagination, but it cannot deny the primary role of significance. It is not an accident that so many contemporary artists today are trying to find their way back by decorating chapels.

The language of words and forms, of rhythms, of symmetrical or asymmetrical contrasts of frequency or intensity, is the realm of human freedom. It is tied to the biological base and rests upon pragmatic, social significance, for speech and figurative representation are the cement that binds the constituent elements of the ethnic cell. At the same time—and this is exclusively human—it offers the individual artist or spectator a liberating escape while holding them safe within the collective mentality or the nonconformist dream.

The twofold nature of art—collective and personal—makes it impossible to separate the functional completely from the gratuitous, to separate art for something's sake from art for art's sake, just as it makes impossible (except at their extremes) a radical separation between figurative and decorative art.

The Origins and Early Development of Figurative Behavior

We have seen in the first chapters of this book that available technical evidence offers an unbroken series of records from the Australanthropians to our day. This material, in conjunction with data concerning the development of the brain, has been used in an attempt to draw an outline of a paleontology of language, for which no evidence exists before the earliest written forms. There is no material at all for a paleontology of figurative behavior from the earliest times until the Upper Paleolithic, but from that date the figurative evidence covers some thirty thousand years, as against the mere five thousand or so years of written evidence for the development of language. The fact that graphic figurative representation appears to be as old as the *Homo sapiens* species is extremely helpful. The problem lies in choosing an appropriate hypothesis for the behavior of earlier anthropoids. One possibility consists in inquiring whether all figurative activities (motor, vocal, or instrumental) are similar to graphic representation: if so, we cannot expect to find anything before the last Neanderthalians. Another possibility is to try to unravel the relationship between figurative representation and language, an approach that may provide a slim but valuable clue based on the development of the brain.

Figurative behavior, as we have seen, does not extend either to functional aesthetics or to the senses incapable of symbolic reflection, namely smell, taste, and touch. Its only possible vehicles are hearing, sight, and the physical faculty of gesticulation. Given what we know of the apparatus of the higher mammals and humans, these dominant reference senses (sight and hearing), together with motor function, indicate that figurative behavior forms part of the system of responsiveness. In other words, its instruments are the same as those of technics and language: the body and the hand, the eye and the ear. The activities we distinguish as dance, mime, drama, music, and graphic or plastic art all spring from the same source as the activities connected with technics and language. This common origin notwithstanding, the paleontological approach, which enabled us to show the development of the cortical areas of conscious motor function and the contiguity of the areas in which technical and verbal sequences are integrated, does not seem to be indicated, except perhaps as a means of confirming that language and figurative representation stem from the same human aptitude, the aptitude to abstract elements from reality and from those elements to reconstitute that reality's symbolic image. But whereas the purpose of verbal figures—words and syntax—is, like the purpose of tools and manual gestures, their equivalents, to provide an effective hold on the world of relationships and of matter, figurative representation belongs to a different biological field, that of the perception of rhythms and values, which all living beings have in common. Thus we see that tools, language, and rhythmic creation are three contiguous aspects of one and the same process.

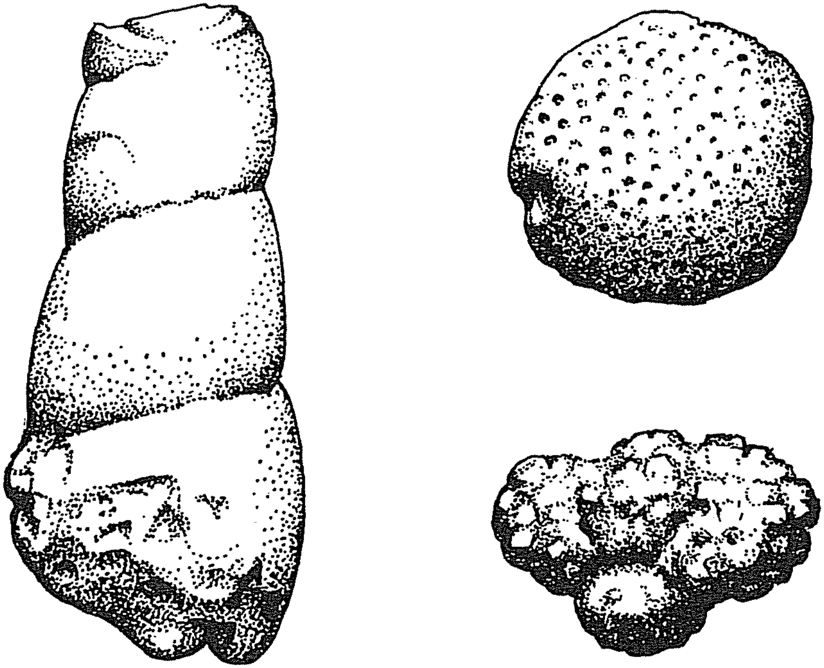
The data that derive from this contiguity can be applied only very indirectly to anthropoids earlier than *Homo sapiens*. We have seen that rhythmic percussive actions of a technical nature were already being performed by the Australanthropians, the earliest known anthropoids. The first tools were made by series of impacts and were employed through repeated percussive actions. Sonar rhythms of a technical rather than a figurative nature can be assumed to have existed from the very beginning: Rhythmic swaying and repeated sound signals are well enough attested in the higher mammals to be credited to the earliest anthropoids. Of the motor and sonar forms of figurative representation it can be said that they have existed virtually from the moment of emergence of the earliest anthropoids, just as it can be said of metallurgy that it has existed from the moment when, with ore already known as a coloring agent, fusible ores and the high temperatures employed in pottery had only to come together for metals to be born. Because the separate elements existed before the specific phenomenon, no precise point in time can be established for the emergence either of motor figurative representation or of metallurgy. In the process of geological development, voiced and gesticulatory figurative rhythmicity probably emerged, like language, simultaneously with the development of techniques.

There is no reason to suppose that the level of figurative activity at the Australanthropian and Archanthropian stages was any different from their technical level. A period of several hundreds of thousands of years lay between the first chopper and the last biface. As we saw in chapters 4 and 12, forms had to evolve extremely slowly toward symmetry and functional balance before the tools of the period began to show anything that can be interpreted as a concern with regularity of curves or with careful finish. Even if the concern was not yet conscious (in a worker who was still only a Pithecanthropian!), even if the balance of forms the worker was able to achieve must be viewed simply as the expression of a zoological property, the fact that he or she possessed the means of foreseeing the form in the material and of bringing it to the threshold of aesthetic perfection should suffice to make us suppose that humans earlier than Neanderthal man had achieved a corresponding level of figurative activity. We can be certain that this level still fell short of engraving or painting, for these are barely foreshadowed in Neanderthal man even at the end of his long career on earth. But very rudimentary forms of dancing, singing, and percussion can reasonably be imagined, for if the roots of technics go back as far as the Australanthropians, there is no scientific reason why the roots of language and of rhythm should not do likewise.

The Earliest Images

The place of figurative behavior in the sphere of motor function and sound will always be a matter for conjecture. It is practically certain that Palaeoanthropians sang, but what figurative elements did their vocal exercises contain? One would be inclined to suppose that the expression of feelings outweighed the formulation of complex ideas. One could advance the hypothesis of hunting songs, but it would be as gratuitous as to postulate funeral chants. All we know is that Palaeoanthropians hunted and that they cared about their dead. On the other hand, the earliest signs of fossilizable figurative representation are not lost to us, for while we know but little of the Archanthropians' and the early Palaeoanthropians' dwelling places, dozens of sites of Neanderthal dwellings have been uncovered. Between these sites and those of the Upper Paleolithic lies the birth of the art of engraving, painting, and sculpture—a birth so gradual that we can be completely sure that these were their beginnings.

The earliest fragments of red ocher found go back to the end of the Mousterian period, around 50,000 B.C., but no works exist to prove that this ocher was being used as a coloring agent. We may suppose that it served to decorate human bodies or to coat objects or surfaces, but the only positive fact that emerges is that this was happening at least twenty thousand years before the first known explicit figures were created. A few engraved lines or cupules hollowed out of stone are known to belong to the same period. Piles of spherical stones have also been found in Tunisia and France. Thus the first glimmerings appear a little before *Homo sapiens,* and their character becomes more clearly defined with the discovery of some objects that Neanderthalians brought into their caves at Arcy-sur-Cure, a very advanced Mousterian habitat. These objects are two lumps of iron pyrites formed of rough agglomerated spheres, a cast of a large fossil gastropod shell, and a spherical polyparium from the Mesozoic era (figure 128). No descriptive significance can be perceived in these vestigial finds consisting of a few spheroids and a spiral, but they represent the first attested evidence of shape recognition. They are also the first sign, and a most important one, of human fascination with the fantastical in nature. Our aesthetic feeling for the mystery of strange forms—shells, stones, teeth or tusks, fossil imprints—



128. Natural objects gathered by Mousterians, Arcy-sur-Cure, Yonne, France. From left to right: gastropod mussel, spherical polyparium, lump of iron pyrites.

is rooted in a very deep stratum of human behavior: Not only is it chronologically the first attested aesthetic sentiment, it also represents the adolescence of the natural sciences, for the dawning of science in all civilizations took place amid the bric-à-brac of so-called curios. A connection between this predilection and magic can easily be established, but for the present the bare fact is significant enough: Before figurative art proper, there was already something more obscure or more general that corresponded to a reflective recognition of forms. Unusualness of form, a powerful mainspring of figurative interest, exists only when individuals can set objects entering their field of perception against an organized picture of their universe of responsiveness. Objects that do not directly belong to the living world but exhibit its properties or a reflection thereof are unusual in the highest degree. The living world of animals, plants, heavenly bodies, and fire, immobilized in stone, is to this day one of the sources of the modern interest in paleontology, prehistory, and geology. Concretions and sparkling cyrstals go to the very foundations of human reflective thought—they correspond in nature to what words or thoughts are to us, symbols of form or movement. Unusual forms are mysterious and even disturbing because in them we discover a kind of congealed reflection of thought in nature.

It is very interesting to note that throughout human experience the first origin of every spontaneously figurative aesthetic, whether in individuals or in whole cultures, has been the same. Gold, diamonds, and precious stones derive from the same source as the curiously shaped stones of the Mousterians: the fascination had already reached its peak in Neanderthal man. Whether he already connected his "curiosities" with magic is difficult to tell, but we can be sure that this was so a few thousand years later. An unbroken line leads from the first curios to the antique-shop window of today. Prehistory tells us that the Upper Paleolithic began in the ancient Western world, in the Châtelperronian or Aurignacian periods around 35,000 B.C. The dating is not fortuitous; we have already seen that the ten millennia in which our human universe was constituted were marked by several facts of capital importance—the loss of the prefrontal ridge, intensive diversification of technical products, complex habitat structures, the earliest figurative records. We have seen that rather than being a sudden upheaval, the development had been long in preparation among the Palaeoanthropians and that, from a certain level of maturity onward, human societies were rapidly transformed by the multiplicity of possible new associations.

The Châtelperronian, the Aurignacian, and the Magdalenian, between 35,000 and 10,000 B.C., provide very extensive evidence of fossils and minerals (ammonites, belemnites, trilobites, quartz and galena crystals, iron pyrites) gathered by humans. There is a direct connection between these and the countless examples of curiously shaped stones and unusual objects found among both primitive and civilized peoples. Historical evidence as well as lived experience teaches us that the value connotations of this type of heterogeneous material in the post-Paleolithic world stem from a complex intellectual whole made up of aesthetics, magic, and pharmaceutics, whose separate strands it is practically impossible to disentangle. Art found in nature forms part of the same order of concerns as human art, and there is no reason to suppose that it is any more "gratuitous." The development of the aesthetics of natural forms in the great civilizations is of special interest in this connection, the cabinet of curiosities playing exactly the same role for the Chinese and the Japanese as for Europeans. Between the Middle Ages and the nineteenth century a strong collecting tradition rooted in the aesthetic enjoyment of rare and spontaneous forms sprang up in Europe. It was no longer wholly oriented toward magic but, via traditional phases such as alchemy, toward evolutive forms of magical knowledge—the pharmacopoeia and the natural sciences. Our own "museum," heir to the cabinet of curiosities of earlier times, remains to this day a storehouse for strange objects, monstrous and exceptional natural forms, and bodies that fail to meet the criteria of "normalcy."

In the process of exteriorization or liberation characteristic of contemporary arts, our art today, like that of the Far East for centuries past, approaches natural forms from a purely aesthetic angle. At an aesthetic level, "*art brut*," oddly shaped stones or roots, crystals, fishes pressed between two sheets of shale, have something in common with the Chinese garden of hundreds of years ago, but a connection—which reassures us about the unity of the human race—also exists between them and the late Palaeoanthropians' predilection for curious natural forms.

Figurative Rhythm

Reference has already been made to those mysterious bone fragments or sticks bearing regular incisions which are known as "hunting tallies" (figure 82). Their first appearance may date back to the late Mousterian period, and they were certainly already frequent in the Châtelperronian and continued until the end of the Magdalenian. The significance of these parallel incisions, which are also found on slabs of stone or on large bones, is unknown. They have been interpreted as a system of counting game, or of keeping a calendar; at the present stage of knowledge, the answer hardly matters. Elusive as they are, these marks denote deliberate repetition and, consequently, rhythm. From the time of the earliest figures, rows of lines or cupules are associated with female symbols, a fact that does not preclude rhythmic figurative representation. Whatever the meaning of the rows of lines, they are the first evidence—some 35,000 years B.C.—of figurative representation.

A little before the beginning of the Solutrean, hollow bones bearing perforations at regular intervals appear upon the scene. Records are rare, the best being those found in the Isturitz cave in the French department of the Lower Pyrenees; a similar object was also found at a Magdalenian site (Molodovo V.) in the U.S.S.R. These objects, dating back to about 20,000 B.C., would appear to be the earliest known musical instruments. This does not mean of course that they were the first such instruments made but only that the bone used in making them was capable of being preserved; we are free to imagine the whistles, flutes, or harps made of wood, osier, or mammoth-hair that will doubtless remain unknown forever. The evidence, though very slender, is conclusive: Between the 35th and the 20th millennia B.C. the human had already mastered the figurative representation of rhythm.

Graphic and Plastic Figuralism

The prehistoric human's music, dance, and poetry are no doubt lost beyond retrieval; the furthest we can venture to go is to suppose that their average level was not below that of the painting or sculpture of the same period. To recognize this is to regret their disappearance even more keenly. Available records of the visual arts are, however, so abundant and so precise that we are entitled to speak of an evolutive trajectory, the longest known in all the arts, for it stretches from about 30,000 to about 8000 B.C.

With the exception of a single site near Lake Baikal in Siberia, Paleolithic art is, at the present stage of knowledge, confined to temperate Europe between the Urals and the Atlantic. Its figurative unity in space and time is remarkable, for it invariably represents a group of male and female human figures and animals, for the most part horses and bison. We need not, in our present context, discuss the apparently highly complex system in which these symbols are organized, although it should be emphasized that both the figures painted on cave walls and those engraved on slabs express a form of coherent religious thought and that these works are certainly not fortuitous accumulations of disparate figures. Statistical analysis of several thousands of cave paintings or art objects reveals the existence of a central theme: man/woman and (or) horse/bison, expressed in a manner that met the prescribed conditions for rendering what was probably the content of a myth. Notwithstanding considerable variations between one region or period and another, this content prevails uniformly from the Urals to the Dordogne and Spain. The conditions are therefore as good as those offered by Christian iconography for the study of the evolution of figurative behavior between the second and the twentieth centuries A.D.

It is also important to note that technical constraints are independent of time. Art is a better instrument than science for measuring the progress of humanity. Although thirty thousand years had to pass before the intelligence of the Aurignacians could be applied to electronics, their ground ocher and manganese made good paints, the hair of animals they hunted made good brushes, and their flint gravers were so strong that they could have been used on steel. In other words, their artist's materials provided them with means of expression equal to those available to us today. These materials had already begun to come into existence in the late Mousterian, but from around 50,000 to about 30,000 B.C. they were not yet being applied to naturalistic figurative representation. Gravers were employed for working bone and coloring agents used for purposes of a no doubt decorative nature of which we know nothing.

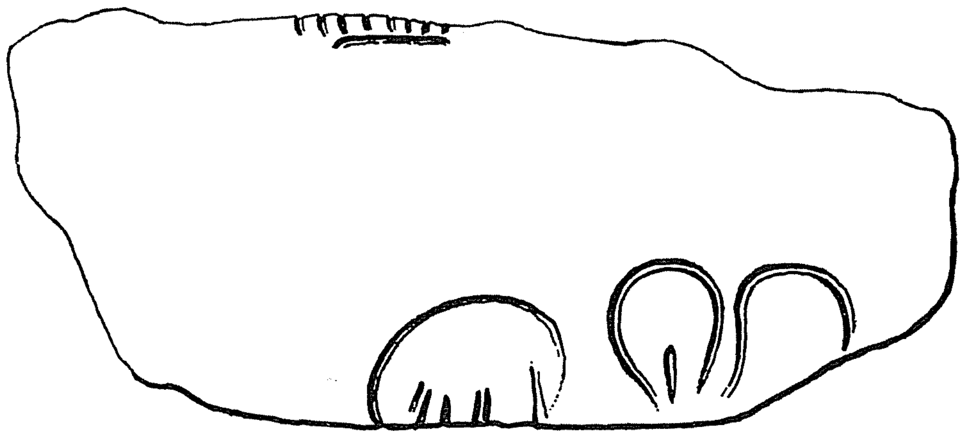
This *pre-figurative period* includes the earliest activities—collecting curios, engraving parallel lines or rows of cupules, widespread use of dyes—but there is no record of any figurative work. It extends over the Chatelperronian and continues into the Aurignacian. During the latter period, between 30,000 and 25,000 B.C., the first figures begin to appear.

The first stage of development is attested by a few precisely dated sites in France and Spain, one of which (the Cellier shelter in the Dordogne) was the source of a series of chronologically distinct Aurignacian works and two others (La Ferrassie and Isturitz) of works ranging in time from the Aurignacian (around 30,000 B.C.) to the middle Gravettian (around 23,000 B.C.). In addition to these three main sites, tallying evidence has been found at half a dozen others; in my previous writings I have referred to these records under the heading of "style I" or *primitive period.*

So far as their execution is concerned, these early works are just what might be expected of a first attempt. They consist of slabs of limestone bearing incisions of parallel strokes or rows of cupules, clusters of intertwined lines, and curves roughly organized into animal heads and female symbols (figures 84 and 85). Between the Chatelperronian and the middle Gravettian the figure drawing becomes more mature; the figures stand out more clearly and the animals become zoologically identifiable.

The first fact that strikes us is that although rhythmic markings precede explicit figures in time, these figurative visual symbols appear to belong to the same context, as though added on for greater clarity. The explicit forms are, first, oval female shapes (figure 129) (representations of the complete female body were to come later) and heads or front parts of animals of unidentifiable shape. At all the well-preserved sites, especially the Cellier shelter, the figures are grouped systematically as follows: rhythmic marks–vulva–animal. The same elements, almost unrecognizable in terms of realism and skill, would still be there ten thousand years later at Lascaux and fifteen thousand years later in Sicily—the relationship between the periods concerned being somewhat like that between, say, paleo-Christian graffiti, the Ravenna mosaics, and the frescoes of a twentieth-century basilica.

There is no word more appropriate than "primitive" to describe the first known art works. We thus see that primitive art began in abstraction or even in the pre-figurative. The works were not, as is still sometimes claimed today, a kind of explosion of enthusiasm that occurred spontaneously when prehistoric hunters answered the promptings of inspiration or appetite by drawing the forms of their naked goddesses, the mammoth, or the reindeer. They reflect the very slow development—lasting more than 10,000 years—of efforts to render with the hand a con-



129. Engraved stone of the Aurignacian of Dordogne, on which are female symbols and rhythmic incisions.

tent that verbally had already been mastered. The reason for Paleolithic man's endeavors to construct his assemblages of symbols was that he had something to express. In chapter 6 I attempted to bring the first graphic works into relationship with language; here it may become clearer that art was abstract at the very start and that its origins could not have been otherwise.

Abstract Art To abstract, in the strict etymological sense, is to "isolate mentally; to consider a part by isolating it from the whole." This definition perfectly fits the earliest forms of prehistoric art, which first selects some expressive feature (phallus, vulva, bison's or horse's head) and then assembles them in order to translate a mythological whole into symbols—to create a mythogram. In the history of all arts, abstraction is resorted to either at the initial or at a late stage—or at any stage, for reasons of practical necessity, as with writing, heraldry, or advertising. It is precisely the freedom, or rather the relative freedom, of its evolution that differentiates figurative art from technics.

The first conclusion to be drawn with certainty from the available facts is that figurative art came into being in a logically consistent manner, somewhat like a gradually outcropping geological stratum: The tip of symbolizable thought appeared first, long before any realistic organization of figures was possible. The event we witness during the millennia that follow is the slow rise of realism.

Realism and Schematization A completely satisfactory definition of these terms is difficult to find. I shall try to restrict the meaning of "realism" to an advanced trend toward figurative representation that is "accurate" as regards form, movement, and detail. Certain late Magdalenian engravings of reindeer or horses will stand up to having photographs of the same animals in similar movement superimposed upon them. We may therefore speak of "realism" in their connection. But the term is always, in a sense, misleading: Some detail of an animal's coat may, for example, have been overlooked, in which case a certain degree of *schematization* will enter into play. Another peculiar phenomenon that may occur, and frequently does in the case of figures on wickerwork or fabric, is *geometrization,* the reduction of images to triangles or other geometric forms, the original meaning of the figure often being lost to the artist. As for *stylization,* the term would be useful were it not applied so carelessly, generally as a synonym for "schematization," whereas in fact it ought to connote the imprint of a particular place or epoch. A Chinese horse from the time of the Han dynasty is "stylized" according to a formula in which the realism of form, movement, and detail undergoes a certain schematic distortion entirely peculiar to a Han horse. The term "stylization" is of little value unless it connotes a specific process; otherwise it is preferable to speak simply of "style."

Another value that should be considered is *decoration,* a practice common to all arts—plastic, musical, and gestural—consists in filling whatever blank spaces the composition may contain with suitable decorative matter. All these terms—realism, schematism, geometrization, decoration—are in common use and are defined here only to avoid misunderstandings. All these elements played a part in the development of paleolithic art and can therefore provide us with a vital lead.

In quite another field, mention should be made of *spatial integration,* which has to do with both *composition* and *perspective.* Lastly, figurative expression has to take up a position vis-à-vis the real universe, at any rate as it is analyzed by the senses. Figurative representation, whatever its means, can conform to commonsense reality—in which case it will tend toward perfect realism—or it may seek to achieve fantastic ultrareality as in surrealism, or infrareality as in nonfigurative art.

The frequency of possible combinations of all these different terms are variable. Realism in all the arts must include some degree of schematization, but it excludes geometrization, except possibly by transposing it to the compositional level and turning it into the chief element of spatial integration. Decoration often entails the fantastic—without excluding realism—or tends toward geometrization in its elements or in their composition. The paleontology of forms is brief because it does not begin earlier than the emergence of *Homo sapiens.* But the available records do seem to imply a real beginning, and it is of interest to inquire to what extent the common values of historic times apply to an art that had already been in a fossil state for seven thousand years when the earliest roots of Greek art began to grow.

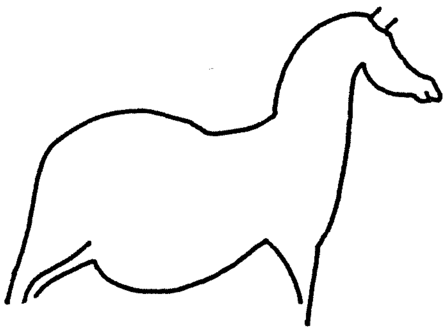
Paleolithic Realism

Developed realism in its threefold aspect of form, movement, and detail is acquired very slowly; truth to tell, it represents a rather disturbing form of maturity in the life of the arts: We need only think of archaic Greek statuary, classical sculpture, the statues of the Hellenistic period, and those of our public parks and war monuments. Egyptian or Chinese art could easily give the same impression. Individual talent apart—for individual talent can produce masterpieces at any stage of an art's development—it would seem that with the passage of time every formula in art tends toward the point of coincidence between the image and reality. In other words, it seems that there exists in the arts a phenomenon similar to that of functional approximation in technics (see chapter 12). The time drift brings in imperceptible corrections that steer the art work toward an ideal state in which it will no longer be distinguishable from its model or toward a balance of values so miraculous that only repetition or a decline can follow. Then, it seems, a new cycle begins and the conditions for expression change. The parallel between the two phenomena is not, however, complete. In technics objects really do proceed toward functional perfection, thanks to the emergence of new raw materials. The examples we have cited show that their development is made up of sections of a trajectory telescoping into a single, steadily rising curve. The situation with regard to the arts is different: The role of material means is negligible—red ocher is still being used by painters, and it is no better than the red ocher of the Aurignacians. New materials need not emerge, and art may remain turned in upon itself for long periods, as has been the case with Chinese art during the past few centuries. The way out then lies in radical changes of direction, sometimes even in completely fresh departures upon a new trajectory. These are practically always caused by upheavals of a socioeconomic nature, for the arts rarely survive a radical change within the group's internal environment. These insights derived from history would of course be greatly enhanced if they were confirmed by a possible trajectory of Paleolithic art, and this, it seems, can now be established.

As we have seen, style I figures testify to a departure into abstraction; their schematism is such that the forms are only just identifiable provided you have a key to them. Style II extends over the late Gravettian and early Solutrean, with the midpoint situated around 20,000 B.C. The separation from style I is arbitrary, there being no noticeable break between the two styles, but collectively the works of the successive periods show considerable evolution. Style II is illustrated by several caves, such as Pair-non-Pair in the department of the Gironde (figures 130 and 131) or Gargas in the French Pyrenees, as well as by very numerous statuettes in the U.S.S.R. (figure 132), Czechoslovakia, Austria, and France. In these works the mastery of the burin is complete, and not the smallest suspicion of clumsiness attaches to the authors of the Kostienki, Willendorf, or Lespugue "Venuses." Moreover, the multiplicity of examples and their geographical extension show that figurative "canons" were identical in Russia and the Dordogne, a striking fact which is of considerable help in defining their characteristics.

If we take realism to mean the striving for precision of forms, movement, and detail, there is very little realism in the works of style II. Women, bison, aurochs, horses, are all executed according to the same convention whereby identifying attributes are attached to a central nucleus, the body. The result is that the head and limbs are often merely hinted at and, at best, are out of scale with the mass of the body. In the animal figures the dorsal contours are almost identical for all species; horns, a beard for the bison, a mane, and a more delicate muzzle for the horse make for unequivocal identification, but with a maximum of economy. The female figures are curious statuettes which have been called "Aurignacian Venuses" or "Steatopygous figures," thought by some to represent a portrait of paleolithic Woman. Enormous breasts are attached to a massive body, the head is without detail, the arms are barely sketched in, and the thighs end in short, schematic tapering legs. Viewing the figures from the two extremes of Europe side by side, it would be hard to find a more conventional, more stereotyped art—and this fits in with what we have already said, namely that in the Upper Paleolithic the fragmentation of cultures was as yet little advanced. No movement is perceptible in either animals or human figures, except in the arabesque lines which often have admirable vigor. Detail is practically nonexistent or barely hinted at. Certain works, viewed within this conventional frame and without prejudice as to their accuracy, are admirable. The most conventional of the "Venuses," the Venus of Lespugue, is one of the great plastic works of all time.

Style III is still richer in records and includes bas-reliefs like those of the Roc de Sers in the department of the Charente as well as profusely decorated caves such as Le Gabillou or Lascaux in the Dordogne. It has 15,000 B.C. as its midpoint and covers the late Solutrean and the beginnings of the Magdalenian. This period represents the apogee of the archaic trajectory. As a stage it might be said to correspond to the Han period in Chinese art, fourth dynasty Egyptian art, archaic Greek art, and



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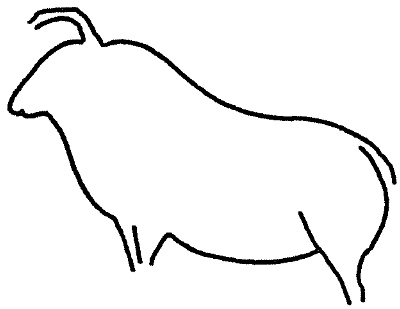

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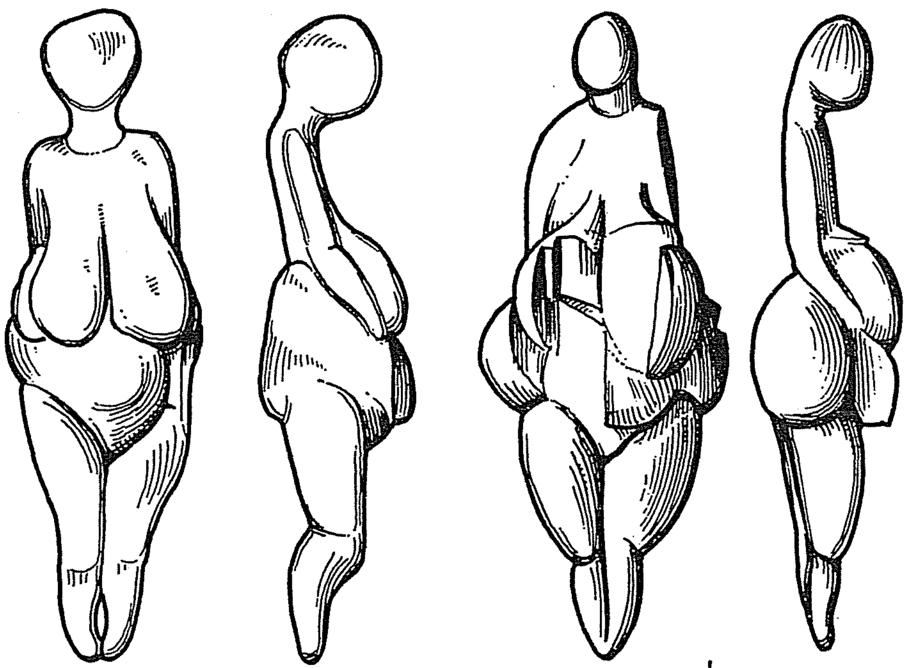

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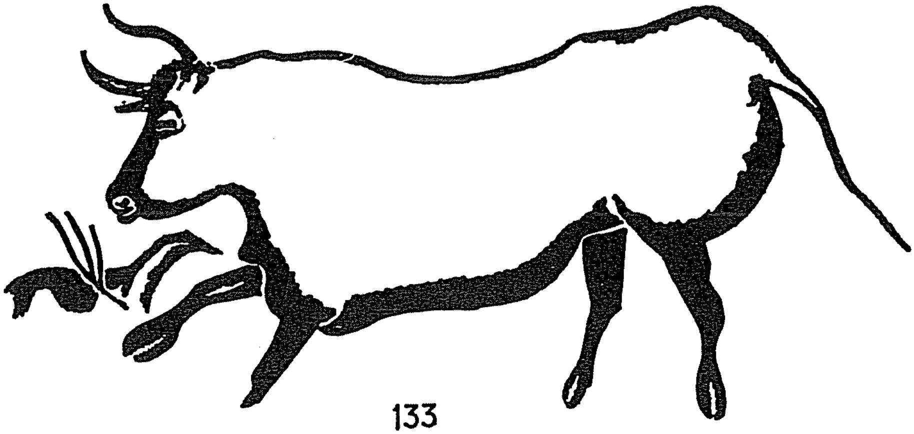
130, 131. Horse and bison of style II. Engravings from the Pair-non-Pair cave, Gironde, France.

132. Late style II statuettes. (a) *U.S.S.R., Kostienki I;* (b) *Haute-Garonne, Lespugue.*

Roman and Byzantine art. The parallel is not based on a mere impression but on strongly pronounced internal features. The representation of living beings is subject, not to a precise transposition of proportions, but to a purely affective interpretation of anatomical characteristics. The canon is still primitive; the bulls and horses of Lascaux (figures 133 and 134) are inflated like bladders in spite of the flexibility of the contour lines, the limbs seem to be plugged into the body in what is sometimes a very rudimentary manner, the perspectives are purely conventional. Each figure lives on its own, and each part of each figure plays its role with the barest minimum of connection to the whole. The execution is served by a perfect mastery of color and of the graving tool. Like those of the arts cited in comparison, style III works give an impression of vigor and youth not to be recaptured in succeeding stages (figure 135). The impression is due precisely to the fact that their realism is an evocation, not a copy. The mysterious life of archaic figures is like the life of curiously shaped stones or roots. It leaves a margin of freedom, an appetite for more; it opens up suggestive vistas. It is a phenomenon of the same order as the introduction of a very slight warp, even of some small deliberate imperfection, in Chinese or Japanese pottery. There can be no doubt that old portrayals of galloping horses are more alive, and consequently more real, than the cold precision of instantaneous photography, for the only way to instill motion into the immobile is by juxtaposing different tempos or by portraying movement that is illogical. No one can tell precisely what movements the Lascaux artists wanted to render; the way their animals do move is odd, as if they were swept up by a two-way whirling motion.

But realism of movement is already coming through: Some animal limbs are twisted to express movement; one of the horses is actually rearing while others are quite convincingly shown to be trotting, but then these works belong to a rather late stage of style III. As for realism of detail, it too is already emergent. In the course of Lascaux's history, some of the horses had their ears repainted two or three times (figure 136), and some archaic stags' antlers were washed away to make room for antlers drawn in corrected perspective. The gradual ascendancy of realism is noticeable in the care with which the figures are filled in and modeled, the horses' manes drawn in detail, the eyes and nostrils meticulously spelled out.

At the time it entered upon style IV, Paleolithic art still had a fairly long way to go before declining into academism. The period covers the middle Magdalenian and late Magdalenian (early and late style IV, respectively); that is, it extends from roughly 13,000 to 11,000 and from 10,000 to 8000 B.C. Several tens of engraved or painted caves, including Altamira in Spain and Niaux in France, are its high points, and thousands of decorated objects provide a very solid documentary basis as well as dem-



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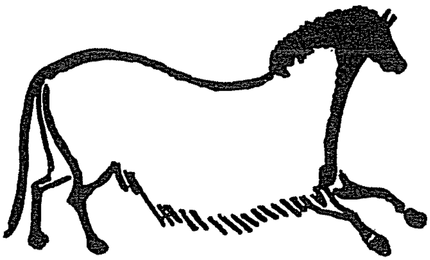

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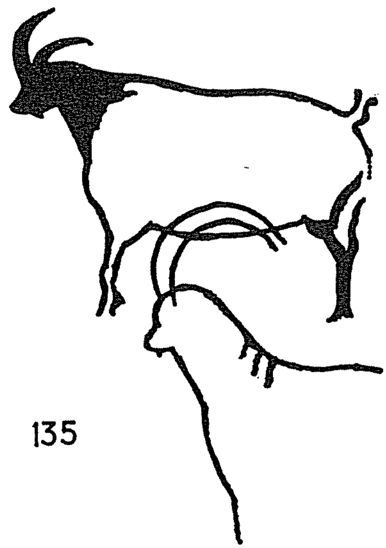

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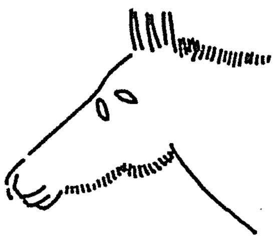

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133, 134. Aurochs and horse, style III. Cave paintings, Lascaux, Dordogne, France.

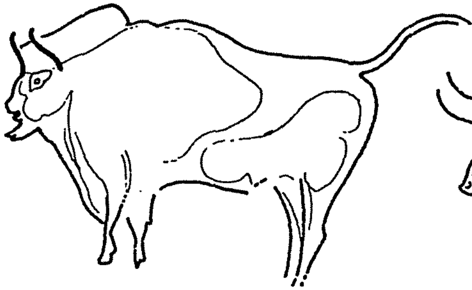
135. A pair of ibex. Paintings found in the Cougnac cave, Lot, France. The proportions and cervicodorsal curves and the perspective of the female's horns are highly characteristic of style III.

136. Engraved horse's head. Lascaux. The ears and eyes were painted twice at different stages of style III.

onstrate, with regional variations, the remarkable unity of the traditions. This is the period of classical splendor. The manner of representation is still just sufficiently out of true with flat reality to bring out the rich savor of the figures. The execution has a subtlety that already borders upon anecdotal liveliness. Art already possesses very ancient traditions of skill, and realism is becoming more pronounced at every level. Realism of action, however, is still almost entirely absent. Until late style IV the compositional elements of the decorations still exist independently of one another and of their framework. There are only three or four examples of "scenes," all of them borrowed from a single theme, that of a man attacked by a bison or a bear. Realism of form, movement, and detail begins to come through more and more clearly. The bisons of Altamira (figure 137) are still as though suspended in an unreal space. But the bulls and cows are rendered with precision despite the absence of primary sexual detail, and the figures of bisons rolling in the dust are already very real. At Niaux the animals' feet already appear to be standing on the ground, and their attitudes have assumed a strongly descriptive character (figure 138). The evolution is still more marked in the detail of the animals' coats and the play of light on the pelts. In both the mural and the movable arts we witness the creation of a real code used uniformly throughout the Franco-Cantabrian region to render the pelt of the ibex, the bison, the horse (figure 139), or the reindeer, a code so precise that the animal can be identified from a mere fragment of a sculpture.

From this point Paleolithic art has only two or three more thousand years to go and the best is already over. Some beautiful works of the late Magdalenian are known, but no great ones. The large cave paintings fall into obsolescence, the sculpture disappears, and the animals engraved on slabs of stone or on reindeer antlers show at best a photographic realism (figures 140 and 141). Paleolithic art died out, together with the earlier conditions of life, toward 8000 B.C. Its legacy may perhaps have lived on in the proto-agricultural communities which were beginning to form near the Mediterranean, but it had become unrecognizable and new arts were setting out on new cycles of their own.

The development of realism in Paleolithic art shows—literally in slow motion and under ideal conditions because cultural crosscurrents are slight or nonexistent—that figurative representation is subject to a maturing process whose stages are connected with a phenomenon similar to that of technical invention: All graphic or plastic innovations are oriented toward an increasingly close approximation to physically accurate rendering. Except in the masterpieces, the increased accuracy is accompanied by a weakening of the impressions conveyed by the works. Skill comes gradually to occupy a more important place, and art becomes irreversibly launched



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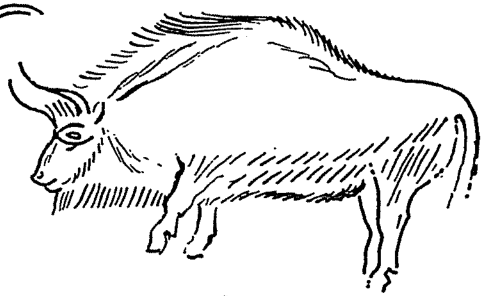

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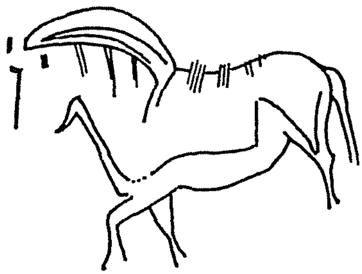

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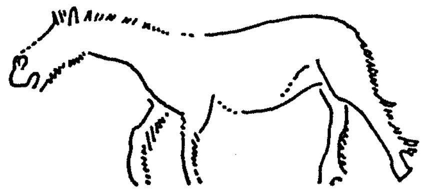

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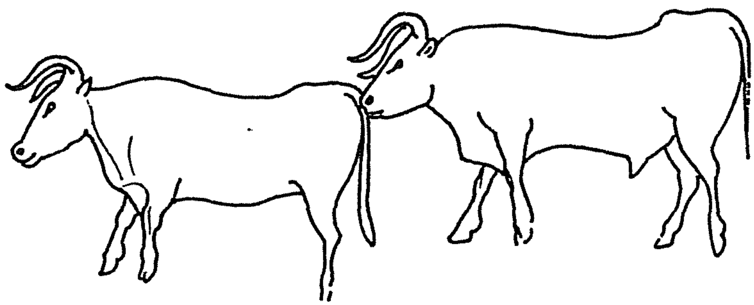

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137. Altamira, Santander, Spain. Early style IV bison, modeled two-tone painting.

138. Niaux, Ariège, France, early style IV bison, painted black with relief suggested by hachures.

139. Le Porel, Ariège, France, early style IV horse, painted black with relief suggested by line markings.

140. Teyjat, Dordogne, France, late style IV wall engravings of a bull and cow. Note the realism of movement and form (after H. Breuil).

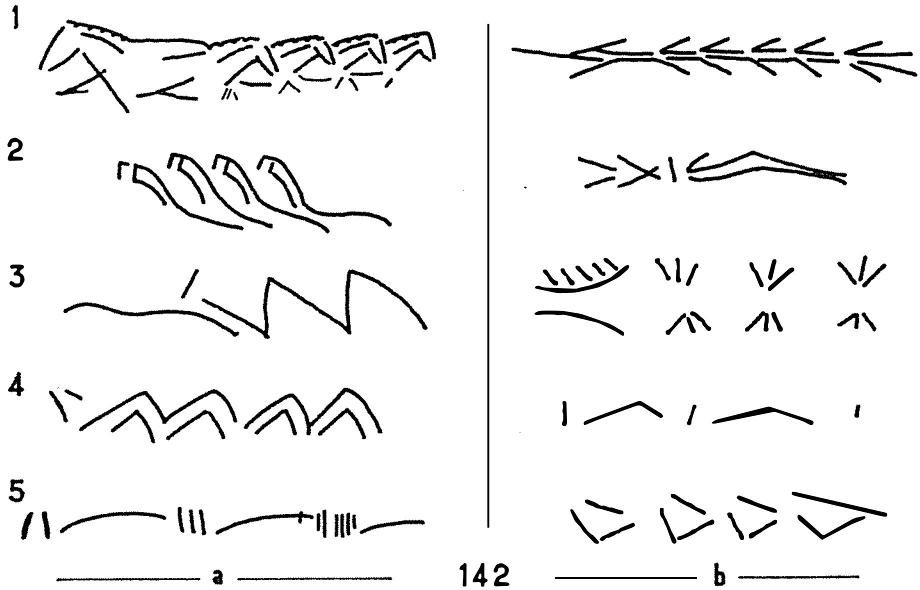
141. Schwitzerbild, Switzerland, late style IV horse engraved on bone. Realism of movement and form.

upon a course leading to academicism and insipidity. The culminating section of the trajectory is that in which the technique is mature but visual integration is not yet completely subordinated to the physical reality of the portrayed object.

The phenomenon of *geometrization* is well established in the historical field. For practical reasons, such as the constraints of weaving or wickerwork, the contours of figurative elements become angular and gradually dissolve into geometrical figures devoid of any meaning. Pottery offers other forms, dictated by the application of decorative matter round the vase or the application of figures by rapid brushstrokes, which gradually wear away into geometricism. This evolution normally affects only decorative procedures in which the rhythm is more important than the subject, and all the arts since the Neolithic can be said to include areas in which geometrization plays some part.

In Paleolithic art the process appears in two different ways. The first is the usual one, and it confirms the general rule. Decorated objects between the Aurignacian and the late Magdalenian fall into three categories. There are figurines, which carry their meaning entirely within themselves, and there are objects serving a technical purpose of a long-term nature, such as pierced rods, or of a short-term nature such as spear tips. The long-term objects are elaborately decorated with engraved or sculpted designs and show a degree of realism consistent with their period. The short-term objects are sparingly decorated with highly simplified engraving often reduced to geometric forms—segments of circles, crosses, lozenges, and so on. As in subsequent cultures, the geometrization of decorative matter is thus determined by technical constraints. The resulting evolution is comparable to that of writing, which is to say that it involves the gradual loss of the subject represented and the forming of a series of signs (figure 142). Geometrization therefore appears as an aspect of extreme schematization.

There was also a second way by which, under certain very special conditions, Paleolithic art arrived at geometrization. We have already said that underlying all European Paleolithic art there is a mythographical theme, obscure to our modern intelligence, involving the presence of a man, a woman, a bison, and a horse within the same group. We know that in style I males or females were sometimes represented by realistically drawn sexual symbols (figures 84 and 85). Very early, perhaps already at the pre-figurative stage, the male symbols began to blend into the series of vertical strokes or dots, although realism made occasional comebacks until the Magdalenian. Female symbols were consistently expressed by ovals or triangles with or without a median line. From style II onward, however, these figures were frequently replaced by nested ovals or by circles. In style III it is the quadrilateral figures



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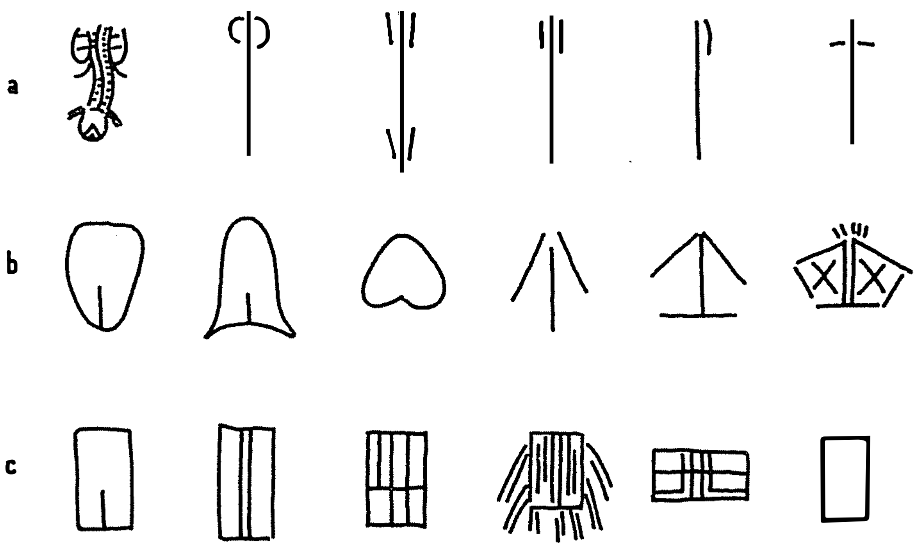

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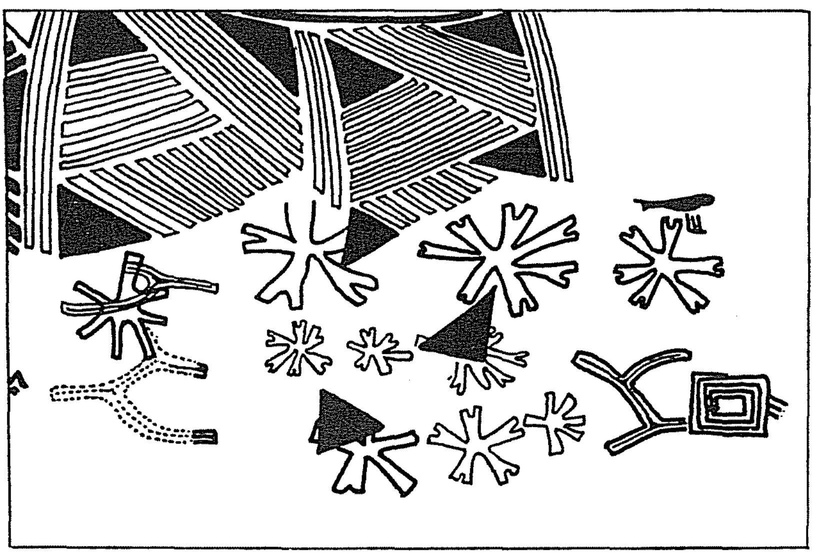
142. Middle and late Magdalenian decorative patterns engraved on reindeer bone or antler (spears or sticks). (a) Geometrization of the theme of a row of horses. The probable stages 4 and 5 defy direct identification. (b) Unidentified geometric themes. Motifs 3 and 4 are very frequent, motifs 4 and 5 may relate to the row of horses.

143. Variations on the male (a) and female (b and c) theme, illustrating the abstract character of sexual representation during the major part of the Upper Paleolithic.

that may be covered with a checkerboard pattern, as is the case with the Lascaux "coats of arms" (figure 143). Although the underlying concern of Paleolithic art was very generally connected with reproduction, and although ithyphallic human figures or figures of male animals with primary sexual attributes are sometimes met with, the vast majority of figures are without such signs, and nothing other than differences in animals' coats or horns or in size distinguishes the males from the females despite the fact that they are often represented in couples. No scene of human or animal coupling is attested with certainty. A strong moral or magical constraint would appear to have operated in this field, which explains why, especially during style III and the early part of style IV, sexual symbols are disguised in almost undecipherable geometrical forms. The esoteric in figurative representation is practically contemporary with the birth of art itself. Far from being a late phenomenon, it is directly connected with the fact that the figures are symbols, not copies. One of the mistakes made by historians of Paleolithic art has been to assume from their modern point of view that works of art had to be simple because they were primitive and gratuitous because they were artistic. But simplicity is not a matter of counting every hair in a mammoth's tail so as not to forget how many of them there are, it is a matter of connecting the language of words with the language of forms. The best proof—were it still necessary to supply one—of the existence of language in the Upper Paleolithic is precisely that words had to exist for the figures to be intelligible. It is therefore very important to note that as far back as 20,000 years before our era, figures could depart from realism of even the most relative kind and assume the form of signs as conventional as those used in writing.

Decoration This term covers a multitude of meanings. Decoration is often a matter of the artist's intention rather than of the actual elements employed: An antique marble sculpture that was the compositional center of a temple may be just one of a number of decorative elements in a park. The decorative intention itself is elusive, a great edifying fresco in a sacred shrine being as much an element of decoration of the shrine as are garlands of leaves. The common factor would seem to be that decoration introduces the concept of composition and integration in space but, in doing so, introduces a hierarchy of values, a distinction between major and minor forms in figurative art. The question we must ask ourselves is whether the concept of decoration was already present in the Paleolithic in both its aspects—which as a rule are complementary—of organizing flat surfaces and volumes with the help of figures whose nature or position is secondary.

Decorative elements are completely absent from mural art, which we shall consider later from the point of view of composition: The caves are like churches from which all superfluous elements other than statues and frescoes, all "padding" such as column capitals, moldings, and gilt have been removed. Filling-in of flat surfaces with geometrical motifs is, however, to be found in works dating most closely to our own time, those of the Neolithic constructions of Çatal Hüyük in Anatolia (figure 144), separated from the Magdalenian by about 2,000 years, and there is also a great deal of other decorative material on Paleolithic chattels. Some of these objects dating as far back as the Aurignacian, such as punches and pierced sticks, are covered in what appear to be purely decorative realistic or geometrical figures. Later, in the Solutrean, throwing devices, spears, and harpoons became added to these objects, and we can imagine the Magdalenians decorating their weapons and their tools as we used to do not so long ago and as is still done in most parts of the world. The aesthetic aspects of such supposition are not in question. The decorations on the tools are carefully composed and in balance with the shape of the object, and the extraordinary artistic perfection of most of the works means that the requirements of integration of the decorative elements are fully satisfied. But the other aspect with which we associate decoration, that of its gratuitous nature, is surely erroneous, for



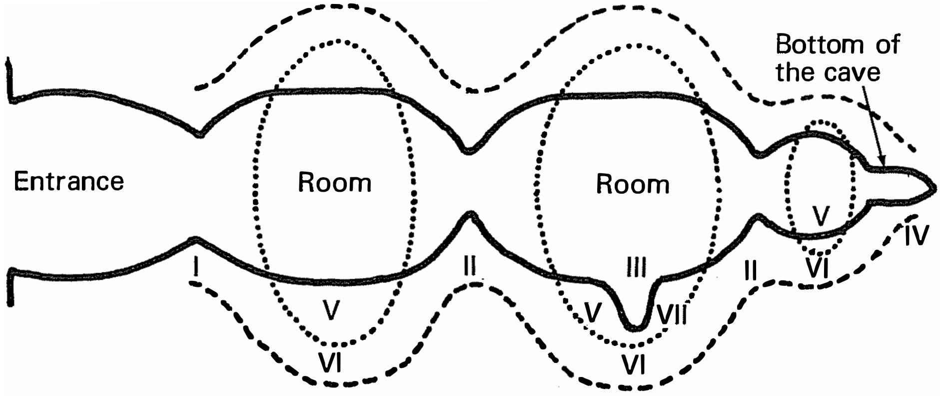
144. Geometric decorative patterns from the neolithic frescoes of Çatal Hüyük (after J. Mellaart).

the decorations not only had a meaning but also fulfilled a function, and the decorations covering the humblest spear did not differ in this respect from the most splendid cave wall painting. The reason why bison were drawn round the hole of the pierced stick and why the handle was decorated with horses appears to be that the object's hole corresponded to the bison, a feminine symbol, and its handle to the masculine symbol of the horse. This is confirmed by the fact that many pierced sticks are not decorated with couples of animals but with symbols of the human couple. Spears, which enter the wound as the male organ enters the vulva, are decorated with rows of horses which become schematized into geometrical figures; harpoons are decorated with fishes, which are also masculine symbols. These facts are consistent with what we know about the relationship between language and figurative representation: From the Aurignacian onward, the objects "speak," and they continue to do so in most cultures where meaning has not yet become divorced from figurative representation. To a certain extent, this remains true of the great civilizations: A Japanese scroll painting of chrysanthemums would not be unrolled in spring, any more than a Christian bishop's crook would be decorated with bacchantes, or a French academician's ceremonial sword with mandolins. In the Far East, as in the Mediterranean world, the divorce between allegorical themes and decorative material was completed in antiquity.

Composition Composition has to do both with the meaning of the figures and with the balance of forms in space. We have seen that Paleolithic people used pictures as mythograms, and we may therefore suppose meaning-related composition to have been present at the very beginning of figurative expression. Figurative syntax is inseparable from the syntax of words. The earliest known figures, those at La Ferrassie or the Cellier shelter, which date to the Aurignacian, already include several sets of the animals, rows of lines or dots, and female oval shapes which were to reappear later on innumerable cave walls; they thus appear to meet the first part of the requirements of composition. A striking feature of the hundreds of known examples, however, is the freedom with which the elements are assembled, a freedom long mistaken for a total absence of order: Swarms of bison, horses dotted here and there, a stag appearing out of nowhere, were enough to confuse the modern eye. The spatial balance of forms, if it exists at all, is not of the same nature as has been known since Neolithic times. This is, once again, entirely as it should be, for, as we have seen, settled agriculture completely transformed the human image of the world. In other works I have described my attempts to identify, on the basis of topographical statistics of mural paintings, the principles underlying the complex cave paintings of Lascaux and Altamira. These principles of composition in space are of a rather singular nature, but they completely coincide with the very starting point of art. The "statistical" cave (figure 145), a cumulative diagram representing eighty actual caves, appears to be decorated in the same manner as the objects, a male/female symbolism providing the basic theme and the topography of the place adding touches of inspiration. Narrow passages and cul-de-sacs are used as female symbols to complement the male ones—rows of dots, horses, ibex, deer. At the very back of the cave, in the last of the successive "rooms," are the most powerful masculine symbols—an actual man, a lion, a rhinoceros. Even the emptiest walls of the intermediate rooms have the complete bovine-equine mythogram painted on them, as well as male and female symbols often surrounded by additional male symbols, mammoth or ibex (figure 146). The organization of space in these compositions is related to meaning, not to the search for balance which comes after many centuries of civilization. The distribution of figures in space is not anarchic—it is adapted, often very felicitously, to the nature of the surfaces—but it is never rigid. The syntax is revealed when we see, several times over as at Lascaux, bulls and a horse confronting a group of cows and a crowd of little horses, the bulls being accompanied by isolated male signs and the cows by female signs supplemented with short straight lines. The intellectual integration of space is therefore perfect, but spatial balance, like realism, is a later acquisition barely perceptible in the late Magdalenian.

The subtle interplay of symmetry or asymmetry in the groups of figures, the fields, and perspectives appears to follow the realism of movement implied by the asymmetrical interplay of limbs perceived in the painting as a whole. Yet, as we have seen, realism of movement—that is to say, the construction of the isolated figure—was still rare and incomplete before the late Magdalenian; at best, lively movement is conveyed separately for each limb. Sophisticated composition and movement, like realism of form, are elements laboriously acquired in the maturity of art. A light sketch of a few trees or a village, even just a horizontal line used as a ground stroke, would have brought Paleolithic art to the level of Assyrian art, but one of its distinguishing feature is precisely the absence of all elements unrelated to the mythographic theme.

Paleolithic art does not disclose any narrative theme. Except in the case of the man knocked over by the bison (figure 147), it does not represent any action other than animal movements that are also animal attributes, such as the "leaping" bisons of Altamira which, in reality, would appear to represent males rolling in urine-sprayed dust in preparation for staking out their territory by rubbing themselves against trees (figure 148). Subsequent arts, even those of recent primitive peoples,



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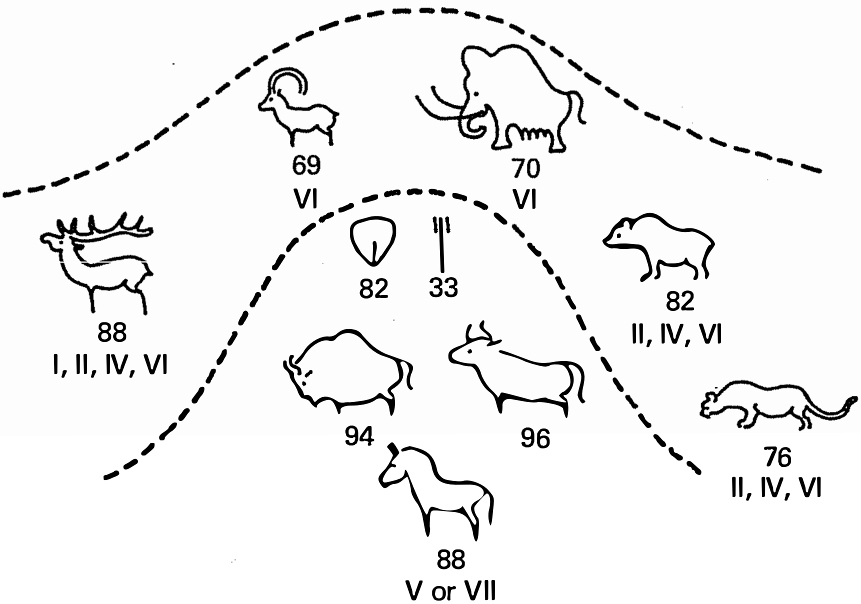

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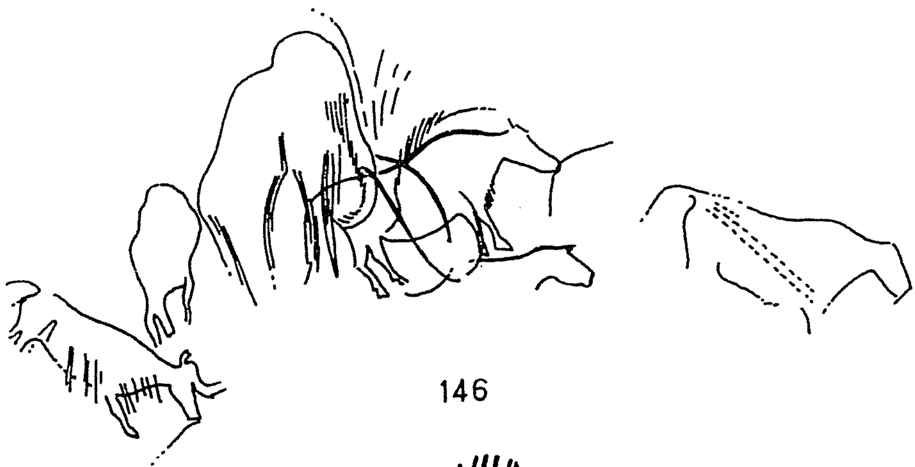
145. Statistical representation of cave decorations: (a) in plan; (b) total area. I: decorations begin; II: the cave narrows; III: entrance to central secondary caves; IV: decorations end (bottom of cave); V: central parts of the "rooms" or passages; VI: periphery of the central parts; VII: interior of the central secondary caves. The numbers indicate the percentage of figures in each of the above-mentioned locations; the use of male and female signs is strictly conventional.



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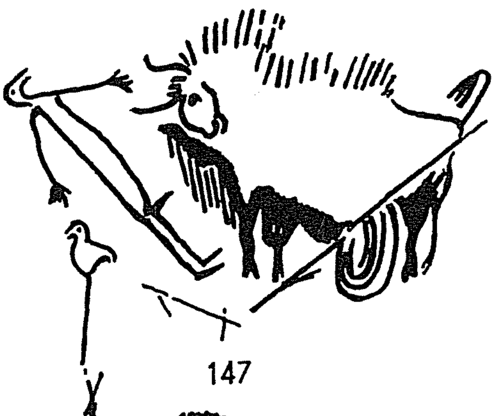

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146. Pech-Merle, Lot, France, composition on the aurochs-horse + mammoth theme, painted in black. Four aurochs are represented: One is in the middle, flanked by a diagrammatic horse and a mammoth, a second one appears to be falling vertically, a third (at the bottom end) has wound marks equivalent to female signs, the last (on the right) bears a virility symbol (hooked rod).

147. Lascaux, man knocked down by a bison. This is a theme known by several examples. It is probably more of a mythographical assemblage than an account based on experience.

148. Altamira, male bison rolling on the ground in order to stake out its territory, known as "the leaping bison."

show nothing truly comparable to the Paleolithic figurative system. Mural paintings like the African ones which represent figures of animals grouped together in a still somewhat rudimentary fashion might come close, but they also include human figures engaged in actions of various kinds, scenes of war, plant gathering, and family scenes; they are composed works, mythographical in nature but filled with identifiable narrative content. The cave engravings of southern Italy, whose inspiration was certainly the same as that of the French and Spanish works but which belong to the last stage of the Paleolithic, suggest a turning point (figure 149): The pairs of aurochs, horses, and deer are still represented in the same apparent disorder, but they exhibit a highly developed realism of form and movement; some of the groups are placed on imaginary ground lines, and the men and women who appear in these engravings are shown armed or dancing, walking, seated, or lying on the ground.

In a different sense the arts of primitive peoples are brimful of painted, engraved, or sculpted mythograms. But the figures have already been thoroughly hieraticized (like the totem poles of British Columbia or African statuary) or the stereotyped elements are repeated by accumulation (as in the mural art of Australia or of the Dogons), or else the composition is organized in narrative scenes (as in Eskimo pictography or Red Indian painting. One of the most interesting aspects of Paleolithic art is connected with its proximity to the origins of figurative representation: Starting from zero with images that are no more than abstract assemblies, and never achieving a higher degree of composition than the simple consistency of the figures, it gradually evolved—in individual figures—toward photographic realism. The next stage, in which narration came to form the framework of composition, had barely begun by the time Paleolithic art disappeared.

Perspective If the compositional stage was only partially reached by the same process of evolution as that which produced realism of forms and movement, perspective followed exactly the same course, for realism of forms, composition, and perspective are closely connected with one another. Perspective for isolated images was achieved as early as in style III, as many examples from Lascaux demonstrate. It was reflected in the manner of drawing animals' horns and ears and of modeling bodies and limbs. This use of perspective had certainly been acquired during style III, some 15,000 B.C.; as we have already noted, some of the Lascaux figures were repainted later in an optically truer perspective. In style IV horns and ears were rendered in a perspective very close to that of the great civilizations, and the manner of modeling bodies had become completely conventional (figure 150). A most singular feature of Paleolithic art is that except in styles I and II, individual figures were ren-

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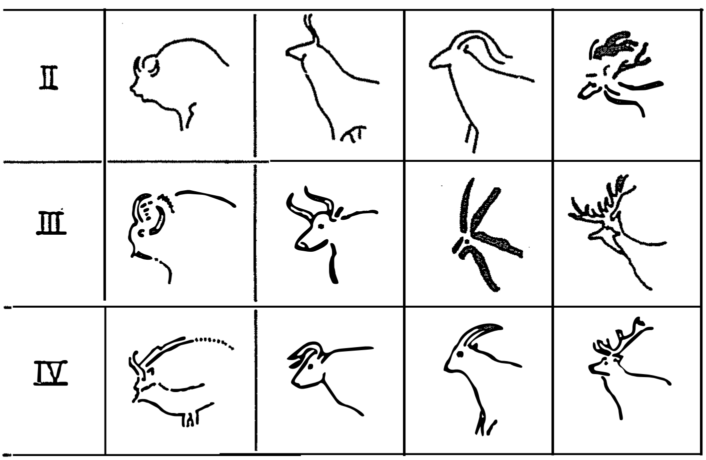

149. Cave at Addaura, Sicily, assemblage of figures showing multiple-action realism. The complete work from which this fragment was obtained is oriented toward the aurochs-horse + stag theme, but the human figures are a new phenomenon.

150. Evolution of perspective drawing of horns and antlers during the Upper Paleolithic.

dered with a degree of optical accuracy achieved by the great civilizations of the Mediterranean and Asia only at a late stage, whereas the level of collective organization of the figures remained surprisingly elementary. Animals or signs were distributed across the painting in such a way as to meet, first, the requirements of the mythogram and, second, those of an aesthetic balance of masses, yet there is no trace of concern with the distribution of planes, no scenography even at a level comparable to that of the Australian churingas, still less any trace of foreshortening or representation in plan as in African mural art, or of effects of transparency by means of which an animal's organs are seen through its body, or of diminishing-scale effects. The composition is optical so far as the figures are concerned, though any attempt to organize them scenographically is lacking. The engravings of the Addaura cave in Southern Italy, Paleolithic in content, already belong to a different world in terms of the positioning of the figures, which suggests a circle of men dancing and an oblique line of individuals walking.

We could ask ourselves whether there is any connection between the perfection of the separate elements and the rudimentary way in which they are articulated with one another, on the one hand, and the evolution of language, on the other. While the horse hunters' technical vocabulary was already highly appropriate, their syntax may have been very elementary. A study of Paleolithic art oriented along these lines might yield some unexpected results in the field of linguistics.

We have seen under what paradoxical conditions the earliest figurative art came into existence: These conditions cannot have recurred other than very exceptionally, for art was never again obliged to develop in isolation. The cycles followed one another, but probably never again did they start from scratch; even the Australian aborigines had some contact with Melanesian ideologies and symbols. There would be little point in discussing every aspect of the "primitive" arts of historic times in our present context, but it is useful to compare classical art with its real diametrical opposite. The comparison, which still fails to bring out completely the essential traits of primitive figurative structure in the absolute sense, disconcerted the prehistorians. What they expected to find were still somewhat simian men who, supposedly by magic or as a pastime, drew game animals and women, pregnant mares, and wounded bulls without any problems of composition because the figures were set down pell-mell on the cave walls, gradually coming to form haphazard groups. This idea was so deep-rooted that it took the work of Madame Laming-Emperaire to show that the apparent chaos of Lascaux was in fact constructed. After eight thousand years of agriculture and other scientific pursuit of exactitude we are very ill-equipped to understand the primitive. In chapter 1 we saw to what extent our image of fossil man was derived from scholars who were themselves often conditioned by their childhood reading. The discovery in Nigeria twenty years ago that the ancient art of Ife was more "developed" than contemporary African art caused much surprise. The feature that proved most immediately striking in Paleolithic art discovered at the end of the nineteenth century was the extraordinary anatomical accuracy of the animal drawing—a real enough accuracy from the middle Magdalenian onward but, before then, as relative as that of, say, Assyrian art. A fact that escaped notice was that the paintings were symbolic assemblies of juxtaposed elements, and that the figurative elements, both animals and human beings, were themselves produced by assembling characteristic anatomical elements whose complete integration had taken thousands of years of unconscious refining, as well as of small individual artistic inventions. Technical obstacles had been mastered very early, but the figurative syntax had remained at a level corresponding to that of the intellectual capital as a whole.

The Fantastic Paleolithic art offers very few examples of what might be construed as flights of the imagination. Its monsters can be counted on the fingers of both hands (figures 151 and 152). The creation of monsters in the art of more recent times derives more or less exclusively from two processes. In the first, a normal theme is transfigured by the addition of decorative elements or by schematization followed by reworking. The jaguar theme in South American art or the sculptures of New Mecklenburg in Melanesia are good examples of this process. The other is the merging together of disparate symbolic figures. There are two ways in which this process normally takes place. The first consists in adding animal attributes, such as a lion's teeth, a bull's horns, or an eagle's wings, to the human figure. The second, a widespread and major source of the fantastic in art, is the merging of animal figures to make a mythographic whole. In two separate works published some thirty years ago, I commented on the way in which, in Chinese art and in the arts of northern Eurasia, symmetrical figures arranged stripwise became telescoped together to make a monster, how the very widespread theme of a bird of prey, a feline, and a herbivore attacking one another merged to produce the chimera, the griffin, and the winged bull and how a combination of the eagle and the snake led to the dragon.

It is interesting to inquire whether any such processes took place in the course of the long story of prehistoric art. Some known cases, such as that of the cat-tailed bear of Rouffignac or the bison-horned horse of Combarelles, were probably the result of coalescence: The bear and the lion are male symbols found in the deep

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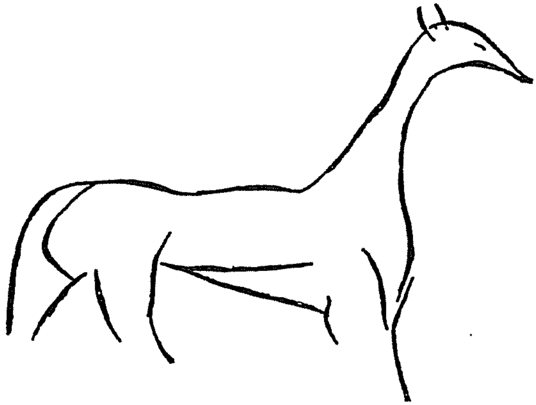

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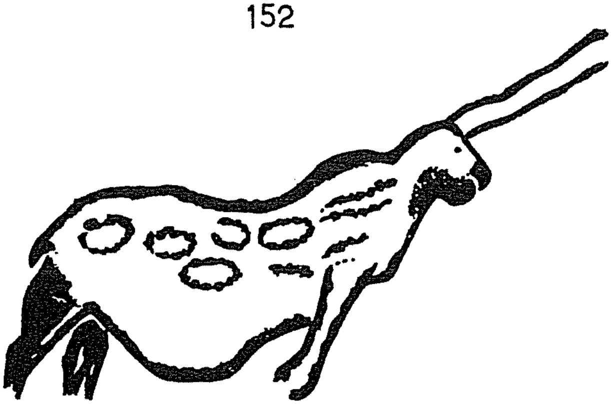

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151. Pech-Merle, Lot, France, "antelope" panel. Unidentifiable animals made up of disparate parts of several species.

152. Le Gabillou, Dordogne, France, the "giraffe." Among thousands of representations of paleolithic animals, the three found here are almost the only ones to resist zoological identification. This particular one even lacks identifiable details.

153. Lascaux, Dordogne, France , the "unicorn."

recesses of caves, and it was almost natural for them to come together. The horned horse panel at Combarelles included only one incomplete mythogram (horse + mammoth); the bison was barely perceptible, and it seems as though the horns had been added to the horse at a much later date so as to restore meaning to the whole. One of the best known monsters was the Lascaux "unicorn" (figure 153), improperly so named because it appears to have two rectilinear horns (which are undoubtedly not its own). No satisfactory explanation is available for the rest of the figure: It occupies a place where a cat might be placed, and it might well be a figure of a panther (an animal which, although rare, existed at the time) drawn according to oral tradition, as giraffes and rhinoceroses were in the Middle Ages. Some anthropomorphous figures, on the other hand, are clearly monsters produced by coalescence. The most famous is the "sorcerer" of the Trois-Frères cave, who has a fairly human trunk and legs, but arms and genitals reminiscent of a cat's, a horse's tail, and the ears, beard, and antlers of a reindeer; his eyes and beak are probably an owl's. What makes Paleolithic monsters different from griffins or hydras is their intellectual—verbal—origin. Chimeras and dragons, sirens, and centaurs are born mechanically, and we can trace their genesis up to the moment where the secondary oral context gives them an existence of their own. The sorcerer of Trois-Frères, by contrast, depends on a context of which he is one of the possible interpretations—an interpretation in conformity with the very nature of Paleolithic figurative representation, which is, fundamentally, a significant assemblage. So far as the position of the figure is concerned, the problem of assembling elements having a male significance could have been resolved in twenty different ways by the use of horses, ibex, deer, or reindeer, and soon, isolated or in groups: The stroke of genius lay in creating a perfectly symbolical synthetic creature.

That Paleolithic thought should have reached so advanced a point may seem paradoxical because we find it difficult to distinguish that which is intrinsically human in ourselves from what is the product of collective maturing. Expression through synthesized symbols is human from the very beginning; obviously, however, the picture of a vulva and a phallus scratched into a block of stone by Aurignacians is not pornography, a stage in figurative representation that took all the maturity of the somewhat overripe civilizations of pre-Colombian America, India, China, and Europe to reach. Most probably our Aurignacians did not even mean to represent copulation—no human or animal figures exist to prove that they did—but rather a more general fact connected with their conception of a universe in which contrasting phenomena supplement each other. All reference systems are ultimately based on the alternation of opposites—day/night, heat/cold, fire/water, man/woman, and so on. The handling of symbols by equivalent groups or by complementary pairs fits in with whatever deliberate composition we can detect in Paleolithic art. The early development of fantastic images proceeded along both tracks, that of combination of equivalents in the "sorcerer" of Trois-Frères and that of binary complementarity in the androgynous images which, although rare, appear to have been executed.

The Nonfigurative

The Paleolithic paradox consists to an appreciable extent in the fact that images of masterly technique and of appealing form can seem to represent nothing of any coherence. To the modern eye, the swarms of animals and signs signify no action except of a most fragmentary kind, and no narration can be detected. We may wonder whether this is so simply because we cannot read or whether there really was no figuratively represented action. The study of comparative art shows that large-scale compositional procedures led all groups to employ explicit narrative forms when representing actions of a technical nature. The mural art of Eurasia and Africa is filled with scenes of hunting, fishing, and gathering and of various domestic activities. Herds have their shepherds or their hunters, men are engaged in *doing*. Religious activities are less often represented figuratively; metaphysical concepts are represented abstractly. But our living arts do not include a single example where the attributes of narrative appear without its form; concentrations of actors without action or stage never occur. A further reason for thinking that what we see in Paleolithic frescoes is represented only abstractly is that they contain several examples of a single theme, that of a man killed by a lion (figure 147), which show that in this case, at least, narrative composition existed in the same forms as everywhere else. If, like many American, Oceanian, or African arts, Paleolithic art had employed only hieratic figures, often schematized to an extreme degree, the problem would have appeared simpler, and we should have been entitled to suppose that art developed in two directions—toward a very conventional figurative representation of entities or concepts, on the one hand, and toward a more realistic figurative representation of actions, on the other. The question is particularly important in relation to recent twentieth-century art. The long road traveled by realism in the Mediterranean civilizations has finally brought it to Puvis de Chavannes and the comics. Parallel to this, abstract art has also enjoyed a long career in the symbolism of religious and astrological signs and in heraldry, eventually becoming detached from its original meaning and transposed into an art whose schematized forms seek to suggest a meaning outside and beyond optical truth. Further than this there appears to be nothing—except perhaps the rejection of all figurative representation. Surrealism proceeded by assembling normally realistic objects in such a way that the final assemblage constituted the negation of realism. Aside from the refusal of significance manifest in certain works, this approach is relatively close to that of the Paleolithic, in that the meaning resides in certain key elements composed in an ultradimensional space but lacking syntax. The fact that surrealism coincided with a passionate interest in primitive arts is obviously not fortuitous. Trying to find a way out by going back to the beginnings of time goes together with rejecting that part of the development of art during which symmetry and perspective were developed and values became ordered in a narrative succession. The difference between the beginning and the end is, however, that the Paleolithic artists were innovating whereas the Surrealists tried to renovate, that is to say, they tried to construct something unconstructed out of scraps of obsolescent material. A really new beginning would require humankind to forget the art of the Mediterranean cultures (which has now become planetary) and cease to understand ancient Greece, medieval Italy, the Flemish, the moderns, all painting—even if it is at odds with tradition—and all music inspired by the maturing of centuries. The social memory exists, its reason for existence is larger than but inclusive of aesthetics, and far from rejecting the past, today's cultures encourage understanding of all the arts, from the prehistoric to the Araucanian. The rise of a new art, an art that would blaze a trail through unexplored country, is an important matter because human dynamism is connected with the creation of upbeat rhythms. The loss of manual discovery, of the personal encounter between human and matter in the exercise of a craft, has closed one of the doors to individual aesthetic innovation. At a different level artistic popularization enables the human masses to live passively on the planet's cultural stock. But art will eventually go the same way as adventure, and Chinese paintings and Mayan sculptures will pall like the cowboys and the Zulus simply because a feeling for art calls for a minimum of participation. The problem of this modicum of the personal in art is as important to the future of *Homo sapiens* as that of the deterioration of human motor function.

The need for a creative solution is already expressing itself in the pursuit of nonfigurative art and concrete music. Since it is apparently impossible to shake off the weight of six thousand years of civilized art, the solution can only lie in the most uncompromising opposition, comparable to that of the ascetic who denies time by refusing sleep and the social order by living naked in the desert. Counter-art is the rejection of realism, form, and the faintest trace of figurative representation, with only the elementary core of rhythm and of contrasting values still being preserved. Taken to its extreme in paintings that are completely white or completely blue, it is a rejection even of rhythm, or, in paintings executed with a spray gun, a rejection of the hand.

Paintings made by throwing, by burning, by lacerating the canvas, and sculptures made of crushed motor cars genuinely represent a return to pre-*Homo sapiens* structures in that, like art which uses uncut stones or roots, they succeed in creating an aesthetic situation similar to that which existed at the time of Neanderthal man, when forms were products of the play of natural forces. The paintings executed by anthropoid great apes, obtained by training though they are, bear witness to a still more intensive thrust toward the very depths of aesthetic behavior, a reimmersion in a rhythm born of the crossing of chance with psychophysiology. These facts are of great interest, for although the bizarre in nature has always aroused strong artistic reactions, the use of chance as the basis for a counterfigurative aesthetic is a fact of typically contemporary importance. In the Far East aesthetes of an ascetic bent have been known in the past to contemplate a garden that was only a surface of white sand, but a surface broken up rhythmically by a black rock that restored it to the scale of a complete universe. That is an example of figurative art pared down to the point of imminent abstraction, and its strength resides in this constantly deferred imminence. Take away the black rock, and no one who has ever lived will see more than a blinding surface, philosophically a paradox but aesthetically a desert. Is the work of today's "painters of emptiness" a sign of rebirth? A sign of weariness it certainly is, but just as certainly a blind alley of creativity. The art of the age-old Eurasian agricultural civilizations will have traveled to the point of total refusal, a point beyond which resurrection is no longer possible and only the birth of a new cycle can follow.

Figurative representation is the language of visible forms. Like the language of words it holds humanity by the root, and the human solution has to be based on the construction of historical trajectories that support the creative urge in a long ascent followed by a fall and by other, newer trajectories. The search for the figurative is therefore written into the future of humankind. The current crisis would become alarming only if, as has happened in the social sphere, the relationship between the mass of passive consumers of art and the creative elite caused the vigor of the search to weaken. At the end of the eighteenth century the transformation of a world that had existed since the beginnings of agriculture began with technics. The great crisis of today was triggered, the forms of society began to change, and, soon afterward, music became the first of the arts to suffer a sea change. Visual art followed more slowly, and it was not until just before the end of the nineteenth century that a shift became perceptible. The situation of the past eighty years is therefore quite normal: It fits into the development as a whole, pretty allegorical frescoes receding into archaeology just as the mail coach did a little earlier. Today's profusion of art movements, the impossibility of telling whither art is heading, the counterfigurative experiments under way, are all signs that the world has entered upon an innovative stage. The future, however, is not without problems. With the coming of photography and especially of the action photograph, optical realism has lost its role as a driving force in most of the older visual arts. The simple forms of primitive symbolism adopted by the great painters and sculptors of the past half-century are transitional forms. The next stage in the arts ought in principle to border on archaicism, with an as yet uncertain mastery of the new relationships deployed in the construction of great monumental works. The art of the new edifices being erected all over the world suggests that such a stage may already have begun. The erudition stored in the world's collective memory encourages reminiscence and so prevents us from recognizing the full meaning of an evolution which, after a short century of reorientation, is taking us back to the stage of the immediate predecessors of the painters of Lascaux.

15 Imaginary Freedom and the Fate of *Homo sapiens*

Imaginary freedom . . . the chapter title could serve as an expression of the pessimism engendered by certain aspects of human evolution. In the case of the wolf and the dog, the price paid for liberation from the natural environment is the dog collar: "social security" tends to restrict not only the risk of too rapid deterioration of the individual's living conditions but also the uncontrolled exercise of personal aptitudes. Freedom, that fragile element of the human edifice, rests upon the imagination, both in the sense of illusion and in that of emancipation through the use of symbols. The Australanthropians' world was already an imaginary one to the extent that it was founded upon the first materialization of what were in effect symbols taking the form of tools; so is the world of an average person of today all of whose knowledge is derived from books, newspapers, and television and who, using the same eyes and ears as our remote ancestor, receives the reflection of a world that has expanded to the proportions of the universe but has become a world of images, a world the individual is plunged into but cannot participate in except through the imagination. Human life being a matter of the interplay between all parts of the body and the mind, we may well inquire whether the human of the hundredth century will still be identical with the traditional human—and whether the human of today still belongs inside the category of *Homo sapiens* or has already gone beyond it.

Several chapters of this book have been devoted to the search for in-depth connections. From our consideration of the zoological part of human nature it has emerged that the zoological human not only continues to share with other mammals the physical organization peculiar to warm-blooded animals but also behavior, which, beneath the veneer of humanization, is still the behavior of an omnivorous social animal for which the constraints of territory, food acquisition, and reproduction remain thinkable and interpretable in zoological terms. Such a view—which could be dismissed as a statement of the obvious or attacked as an expression of crass "bestialism"—appears justifiable for two reasons. The first is that in the course of the ascent of the human, and especially since the invention of writing, a dematerialized image has been formed—an image essential to mental development and to progress, but one which, in the human sciences especially, has led to the denial of any connection between the human and the rest of the living world. When discussing the ape-ancestor in chapter 1, we tried to describe the difficulties with which the search for the real image of the human ancestor has had to contend during the past century. The second reason is that today's widening distance between the human, rapidly becoming the only land mammal of any numerical importance, and the rest of the living world compels us to inquire into the real nature of *Homo sapiens,* born to hunt wild horses in the steppes and gradually adapted to locomotion in a seated position in an atmosphere of burned petrol. Human paleontology and prehistory, whose appeal to human curiosity far exceeds the interest in science, acquire the value of applied sciences when they reveal that the rise of all civilizations was achieved by the same physical and intellectual human that once lay in wait for the mammoth, and that the medium for our barely fifty-year-old electronic culture dates back to forty thousand years ago. We must of course have confidence in the possibilities of further adaptation, but the discrepancy remains. No one can deny the contradiction between a civilization whose powers are almost unlimited and a civilizer whose aggressivity has remained unchanged since the time when to kill a reindeer was to survive.

All psychomotor evolution since the first vertebrates has been achieved through the addition of new territories that did not eliminate the functional importance of the preceding ones but preserved their role, increasingly overlaid by higher functions. The pyramid thus formed was already of considerable size in mammals, but until the great apes it remained geometrically consistent: The neuromotor integration cortex is the apex of a system which, marvelous though it is, remains strictly animal. At the stage of the primitive Anthropians it was as though the tip of a new pyramid—inverted (or, to use the Teilhardian image, "reflected"), more and more gigantic, made up of all the equipment exteriorized in culture—had come into existence on top of the animal pyramid which is and remains the pedestal whereon all human behavior rests. Whereas the base on which we stand is and must remain the osteomuscular system of the last stage of the animal world, the superstructure is wholly artificial and imaginary, born of the interaction taking place externally between the two poles of creative activity—the face and the hand—in technics and language.

One of the things the simultaneous study of the human from the biological and ethnological points of view has shown is that motor activity (whose most perfect agent is the hand) and verbal activity are inseparable from one another. Technics and language are not two distinct typically human facts but a single mental phenomenon neurologically based on contiguous areas and expressed jointly by the body and by sounds. The extraordinary acceleration of progress that followed the unbarring of the prefrontal areas was due to two facts: the incursion of reason into technical operations and the subordination of the hand to language in the graphic symbolism that eventually led to writing.

That is why we must ask ourselves where *Homo sapiens* as a thinking animal is going. After some hundreds of thousands of years when technics and language were balanced within an evolution that proceeded in step with zoological evolution, *Homo sapiens* established a circular balance in which spoken thought became coupled with thought set down in the form of mythograms and later of writing—which incidentally, until the present century, impinged only upon a tiny statistical minority of humankind. The social pyramid promotes intellectual progress through rare individual elements supported by a human mass still balanced in the manner that can be described as "humanly normal," that is to say, an existence where the imagination operates at the level of bodily participation in ceremonies and, in figurative representation, at the level of the mythogram. For a somewhat larger minority, writing has retained its original role; as a process of practical information, rather than as an instrument of speculative thought, it has served to set down laws, keep accounts, and direct the bulk of ideological activity: In all civilizations with writing, religious reading matter, the code of laws, and the handling of figures were the sole diet of the literate masses until the awakening of the eighteenth century. For a short period which, though declining, is not yet over, the prospect of planetary literacy appeared as the equivalent of social and intellectual advancement. The complete subordination of mental activity to the linear process of writing is a promise that can only be fulfilled by a minority having special aptitudes; for most people, reading short inscriptions of a practical nature is the normal thing, while the application of thought to a text—even of a concrete nature—calls for a process of image restitution which remains mentally exhausting. Despite the intensive work of several generations, the paleontological balance soon began to be restored, and as literacy spread to the working classes, the mythogram, in the form of illustrations, reinvaded the reading matter of the nineteenth century. The strip cartoon entered into popular imagery, which had at first been purely mythographic in the larger compositions, and soon pervaded it in the form of small pictures integrated in the text. The linearization of illustrative drawing developed in step with the spread of reading among the masses, reaching its peak in the reading matter of today. Radio, television, and films have completed this return to oral literature and visual information, bypassing any recourse to imaginary forms.

Oddly enough it is by no means certain that audiovisual techniques are really changing traditional anthropoid behavior. We may wonder too what will be the fate of writing in the more or less distant future. There can be no doubt that for several thousand years, quite independently from its role as keeper of the collective memory, writing has by dint of its one-dimensionality provided the analytical instrument indispensable to our philosophical and scientific thinking. The preservation of thought can now be envisaged otherwise than in books, which will not offer the advantages of quick and easy manageability for very much longer. Preselected and instantaneously reconstituted information will soon be delivered by a huge magnetic storage facility with electronic selection. For centuries yet, reading will go on being important—although significantly less so for the majority of human beings—but writing is probably doomed to disappear rapidly, to be replaced by dictaphonic equipment with automatic printing. Should we regard this as a return to the state that preceded the phonetic subordination of the hand? I am inclined, on the contrary, to view this as one of the aspects of the general phenomenon of manual regression (see chapter 8, last section) and as a new "liberation." As for the long-term effects in terms of forms of reasoning, or of a return to diffuse and multidimensional thought, they are at present still unforeseeable. Scientific thought is undoubtedly somewhat cramped by the linear constraints of typography, so a process whereby the subject matter of all the chapters of a book could be presented simultaneously would be of considerable advantage to both authors and readers. But whereas scientific reasoning probably has little to lose through the demise of writing, literary and philosophical forms will surely have to evolve as a result of the same process. This is not especially to be regretted, since the curiously archaic forms employed by thinking human beings during the period of alphabetical graphism will be preserved in print. As for the new forms, their relationship to the old ones will be that of steel to flint: A steel tool is no sharper than a tool made of flint, but it is more manageable. Writing will enter the infrastructure without changing the functioning of the intellect, as a transitional stage that will have been dominant for a few thousand years. The loss of manual activity and the reduction of the human physical adventure to a passive one will cause more serious problems.

The adaptability of *Homo sapiens* is largely conditioned by the social environment. It is safe to say that until the present period, the majority of humans enjoyed normal conditions for the balanced exercise of physical and mental aptitudes in the performance of agricultural, pastoral, artisanal, and warlike tasks. With the primitives, and a fortiori with Paleolithic man, environmental selection operated in the sense that all individuals—with the possible exception of those living in the border area between the natural and the supernatural, such as healers or sorcerers—had to have a certain minimum of psychophysical balance below which survival became precarious. Nothing is known, by the way, about this category of individuals during the Paleolithic but the example of recent primitives suggests that they are unlikely to have lived entirely on the exercise of their functions.

The most profound change in behavior based on the balance between the psychic and the physical was brought about by the transition to city life. The urban environment ensures the survival of categories of individuals—priests, scribes, merchants—whose manual function is all but completely masked by one that is, in the widest sense, verbal or intellectual. Lawyers and traders in all civilizations prepared the way for the long-term regression of the hand or, more precisely, for a transposition of the technical field allowing only very limited scope for manual operations. But all of them used writing; their hands formed words and punctuated their speech; the forelimb had lost none of its importance in intellectual synergy, and we are therefore entitled to speak of a transposition. The centuries have shown that large social groups can adapt and reproduce themselves in a psychophysical balance of the "cerebral" type, but certain major compensatory phenomena have to be taken into account. Active individuals regained a degree of normal balance by traveling on foot or on horseback or through hunting, and social events called for participation of a complex nature. The nonartisanal or nonproductive classes found their anthropoid balance at a slower rate. It should also be remembered that not a few members of the "cerebral" classes failed to adapt and turned to war, overseas trade, vagrancy, or piracy. Lastly, certain classes, especially those involved in the performance of religious functions, were made up of individuals drawn from their original environment by predisposition. Consequently in a traditional civilized environment the exercise of the fundamental behavior patterns of *Homo sapiens* remained identical with the original behavior. Only the range was wider, and individuals physically or intellectually outside the normal run found their place in life as soldiers or philosophers. Despite the many individual failures of adaptation determined by the social systems, society appeared to be benefiting from the full range of aptitudes of the species.

Even today the situation does not appear very different: Society continues to enjoy the use of all its means, though these are increasingly being transposed to artificial organs. The past fifty years with their growing mechanization and control of the terrestrial world have seen a significant reduction in the range of individual aptitudes in many parts of the world. Diminished means of individual creativity and the increasing lack of outlets to the world of adventure have brought into existence new compensations that are gradually moving further and further away from real life. The rebalancing role played by sports and hobby handicrafts, together with the annual interruption created by organized "adventure" on motorways and in camping grounds, is reaching an increasing number of individuals every year. Even hunting is today practiced on semidomesticated boar and deer, penned rabbits, and pheasants imported by air after being synthetically fed. Overpopulated countries are constantly faced with the problem of balance. Yet today's situation is not even a foretaste of what will be our future only a few generations away. The worker's and the peasant's tasks have been only partially mechanized; nature is still present on some beaches, in some forests. War, which for want of the hunt offers an outlet to the least adaptable minority, remains singularly archaic; wars are scattered over the continents like little safety valves, their gangs of misfits knee-deep in mud forming a strange contrast with the silent controllers of atomic rocket launching towers thousands of miles away. But the man hunt has become a myth that supports the premilitary training of millions of youths, the most gifted among whom will perhaps one day pull the handle which will automatically release the bomb at the precise starting point of a trajectory selected by an electronic computer. The conquest of unknown lands too has become a myth, and it is practiced—with the proportions appropriately changed—on the north face of a mountain peak or on a thirty-meter rock face at whose foot the adventure-seekers must wait in line for their weekly treat. The universe has surrendered, cosmic space is open for exploration, but society does not need ten billion cosmonauts; for the ordinary *Homo sapiens,* space travel became a mythical compensation before it was really born. We can seriously expect a time in the near future where only such transpositions will be known and where a corporate body of illusion-making experts will be required to study the psychophysical dietetics of the human masses. Elements of this new discipline are already in existence: so many open spaces, zoological gardens, sports grounds, supported by the vitamin-rich diet of radio and television broadcasts, to balance each period of sedentary productivity. Each year the ration is supplemented by a stay in the countryside: larger open spaces, nature reservations, playgrounds, freedom to put up a tent or sleep in a camper, freedom to heat up a can of food over a gas flame on the ground. A certain margin is still there—it is not yet inconceivable that one might grill a fish one has caught oneself over a wood fire laid and lit by oneself—but in the past ten years such wasteful use of the common stock of treasures has become almost exceptional, and in another ten years' time it will be proscribed as an offence.

We must therefore expect a completely transposed *Homo sapiens* to come into existence, and what we are witnessing today may well be the last free interchanges between humans and the natural world. Freed from tools, gestures, muscles, from programming actions, from memory, freed from imagination by the perfection of the broadcasting media, freed from the animal world, the plant world, from cold, from microbes, from the unknown world of mountains and seas, zoological *Homo sapiens* is probably nearing the end of his career. Physically the zoological species has a certain future. Given the rate at which it has developed over the past 30,000 years, it would seem to have at least as much time ahead of it, although paleontology is not very helpful on this point: Species do not age, they are transformed or disappear. In any case the future that lies before us goes far beyond the rate of human sociotechnical evolution.

The great problem of the world as it already exists calls for a solution: How shall this archaic mammal, with its archaic needs that have been the driving force of its ascent, continue to push its rock up the hillside if one day it is left with only the image of its reality? At no time in its development has this species yet had to break away from itself since the days of the Australanthrope. *Homo sapiens* lived his interminable adventure concretely; today the human is on the point of exhausting the resources of the planet, and already the myth of human transplantation into space has sprung up. But there can be no going back over the ground already covered. We can dream that when arriving on a distant star, the human will encounter Pithecanthropus and the southern elephant but will not revert to flint knapping.

Not to have confidence in the human species would be unnatural, but it is difficult to know in which direction our imagination should be allowed to run. There are several possible solutions to human planetarization. The first, which though never clearly formulated is in the minds of many, is that atomic processes will bring the human adventure to a full stop. That is a hypothesis to be rejected, for the simple reason that, should the accident occur, all hypotheses past and present would have been useless. We do better to gamble on *Homo sapiens.* For the same reason we should be inclined to regard the Teilhardian vision as a powerful mystical approach that bears, however, the hallmark of all apocalypses. Humankind may well have to wait thousands of years for "point omega" and, while waiting, it will have to organize itself and carry on living, just as it did in the year 1000. A third solution consists in the view that the individual is infinitely socializable and that an artificial world functioning toward the well-being of all its cells is more desirable for the individual than the world of the cavedweller, whose freedom to set out in pursuit of a meal was always threatened by the possibility of a chance encounter with a reindeer or a lion. If that is to be the solution we shall, I am sure, have to change the name of our species and find another Latin word to combine with the generic *Homo*. Last of all, we can imagine the human of the near future as being determined by a new awareness and the will to remain *sapiens*. In such an event the problem of the individual's relationship with society will have to be completely rethought: We must face up squarely to the question of our numerical density and our relations with the animal and plant worlds; we must stop miming the behavior of a microbic culture and come to grips with the management of our planet in terms other than those of a game of chance. Whatever the value of the first three solutions, something of the fourth will inevitably be attempted in the century to come unless we decide that humankind has really run its course. Our species is still too closely bound to its origins not to strive spontaneously for the balance that made it human in the first place.

Notes

Part I

1. Lucretius. *De natura rerum* (lines 1282–1285)

> *Arma antiqua, manus, unques, dentesque fuerunt*
> *Et lapides, et item sylvarum fragmina rami*
> *Posterius ferri vis est, aerisque reperta:*
> *Sed prior aeris erat, quam ferri cognitus usus.*
> (They fought at first with hand and nails and teeth
> Stones, branches and [a little later] fire
> And then they learned the use of iron and bronze—
> Actually bronze came first.)—Lucretius, *The Way Things Are: The* De Rerum Natura *of Titus Lucretius Carus,* translated by Rolfe Humphries (Indiana University Press, 1968).

This quotation has been piously handed down for almost the whole of the past century, and I would not wish to break with the tradition. It must be pointed out, however, that in the context in which they are usually cited these lines mean absolutely nothing. In putting bronze before iron, Lucretius was observing a tradition still alive at his time, but the interpretation given to the two lines in which he is credited with having intuited a Stone Age is overly generous. When he says that humans at first used their nails and teeth, Lucretius is making a supposition which, incidentally, is mistaken, since absence of claws and fangs was a characteristic of the earliest anthropoids. When he speaks of "stones," he is certainly thinking of rough stone only. We have absolutely no grounds for construing *lapis* to mean "knapped stone." *Fragmen,* on the other hand, does very clearly mean "broken piece," which indicates beyond a shadow of doubt that Lucretius meant to say only this: "The weapons of the ancients were their hands, their nails, their teeth, stones [which they picked up for throwing] and branches which they broke off in the forests." That is a very long way from the prophetic statement attributed to the "free-thinking poet of Rome" by G. de Mortillet in 1883.

2. N. de Maillet died in 1738. His manuscript was published in Amsterdam in 1748 under the title *Telliamed,* an anagram of the author's name. He was therefore a writer of the first third of the eighteenth century, and this makes his theories all the more remarkable. In the form of a conversation between an Indian philosopher and a missionary, the author—who had been consul in Egypt and was a fervent lover of the natural sciences—tackles the problems of the nature of our planet and the origin of our species. Presented in a form that is certainly not in advance of the geological knowledge of the early eighteenth century, the views on evolution in this work, which precedes the works of Buffon, are singular in all respects. The thickness of strata and the presence of fossils are regarded as a sign of vast upheavals of considerable age; de Maillet does not hesitate to opine that

each of the six days of Genesis may have lasted a hundred thousand years! On the subject of the origin of animals, the book opens curious perspectives by suggesting—in a theory whose terms it is easy to criticize but whose substance is today unassailable—that all land animals, including humans, descended from sea animals. The manner in which he imagines their adaptation to land life to have taken place is rather summary, and when he comes to the human he is obliged to resort to mermen as a transitional stage . . . Yet when, three-quarters of a century later, Lamarck spoke of the hereditary nature of acquired characteristics, he was only expressing the same thought, albeit with the arsenal of scientific data available at his time, which today in its turn has been left far behind. Geological speculation in the early eighteenth century could only be applied to a concept of time still completely lacking in depth, and it is therefore quite natural that *Telliamed* makes short shrift of the transformation into birds of the fish unfortunate enough to have been stranded at the edge of *terra firma:* ". . . the tubes of their fins . . . grew longer and became covered with barbs . . . the growth formed by these pellicles lengthened in turn, the skin became imperceptibly covered with down, the small fins they had under the belly . . . became feet . . ." (*Taillamed,* 1755 edition, p. 167). The fabulous aspect of the book, its deliberate challenge to the scientific gospel truths of its time, made it the object of vigorous attack. It was easy to demonstrate in the mideighteenth century that suns could not give birth to planets, that humans had not come out of the sea, and that fossils were uncontrovertible proof of the Deluge. Later on, scientific progress made the ideas of *Taillamed* read like the ravings of a madman. But if we consider them within the intellectual context of their period, we can hardly deny de Maillet the merit of having understood that the structure of heavenly bodies can evolve, that geological time is incredibly long, that humans followed the same track as the rest of the living world, and that all land vertebrates had evolved from fishes.

3. Boucher de Perthes. *Portrait de l'homme antédiluvien. Antiquités celtiques,* vol. 2, 1857, p. 90:

> This must be true of the human before the Deluge. Without being less intelligent than us, he might show that intelligence in an outward form other than ours, and, like us, be the very peak of earthly creation. Here, longer or less long arms, thinner or less thin legs, even a less or more jutting jaw prove nothing, either for or against. There have been geniuses who could have been taken for cretins if judged by their physical makeup alone. . . .

Vol. 3, p. 459:

> We have adopted the hatchets, we will also believe in the tools. I am convinced that there are great discoveries to be made in this field, and that one day the collection of our first utensils and tools will be viewed with all the attention it deserves, for these tools are our first proof of reason, our first title to the rank of human, title of a kind no other creature on earth can claim.

4. The term "anthropomorphism" is employed here in its strict sense, so-called anthropoid or anthropomorph apes being covered by the expression "pithecomorphism." Anthropomorph really means "human-shaped" and applies to all anthropoids, Australanthropians included.

5. The anatomical facts expounded in this chapter have been condensed from the author's doctoral thesis *Mechanical balance of the skull and land vertebrates,* defended at the Faculty of Sciences of Paris in 1955. They were chosen from among other data as being relevant to a perspective of evolution toward humanity, and developed within that perspective.

6. Anthropologists distinguish between the *cranium,* which is the entire skull including the mandible, and the *calvarium,* which is the skull without the mandible but with the face. They also speak of the *calvaria,* which is the brainpan without the face, and the *calva,* the calotte without the base. I employ this terminology purely as a matter of practical convenience.

7. The interest attaching to the study of technicity in the animal world or to the handful of examples of tools such study has revealed cannot be overemphasized. We should, however, beware of adopting an anthropocentric attitude, which tends to falsify problems.

Cases of animals using tools are extremely rare. Reference is often made, piously and in the same breath, to the Ammophila and its grain of sand, the Galapagos finch and its little stick, the nannygoat scratching itself with a branch held in the mouth, Darwin's female monkey which used to crack nuts with a pebble, monkeys that throw stones, and the gardener bird. The only reason why these examples strike us as spectacular is that they resemble human activities. In no essential particular do they differ from the technicity of the animal world at large, including humans, and to marvel at them is simply to revert to the eighteenth century's naive pronouncements about the industrious bee and the economical ant. One might as well take bipedal walking and, instead of limiting the comparison to the rare moments at which the gibbon walks upright, lump together the bipedal dinosaurs, the armadillo, the pangolin, the jerboa, the kangaroo, and the trained dog—simply show one of the solutions to the problem of walking which we share with the vertebrate world. Listing such solutions held in common is an indispensable means of pinpointing a part of the human problem, of demonstrating in what respect we are just one particular case among others, but it only establishes one component of an answer. Another can be defined by considering our position among species with a pronounced manual activity, a third by examining our position in relation to the general tendency of all nervous systems to increase in complexity. Still other components could be established before arriving at the conclusion that we constitute a whole that is unique in the animal world although composed of elements each of which is extensively shared with other species.

8. The phrenology of the German physician Franz-Josef Gall (1758–1818) has enjoyed a success that in terms of popularity and duration can be rivaled in the field of biology only by those of the theories of Cuvier and Darwin. Gall's theory, which he developed in a number of works, is formulated in the title of the most important among them: *Anatomy and physiology of the nervous system in general and of the brain in particular, with observations concerning the possibility of recognizing several moral or intellectual dispositions of men and animals through the configuration of their brain and their head.* It was violently attacked from the first, and the ridicule its detractors heaped upon it accounts for much of its persistent success. Gall's methods of demonstrating his theory and the character of the affective criteria he employed leave little room for any illusion as to its objective value. Anatomists and physiologists lost no time in giving it the treatment it deserved, but the attraction it exercised upon less scientific minds was great. The "bumps" of philoprogenitiveness, kindness, conscientiousness, or destructiveness, to be detected on the skull, offered plenty of scope to the irony of some and the thirst for scientific mystery of others. The expression "to have a bump for something" (for travel, say, or for cleverness) has entered the language.

It would be interesting to analyze the reasons for the long survival of the phrenological theory. The mystery of the makeup of geniuses, criminals, and cretins, like the secret of the ape-ancestor, has to do with the larger problem of human destiny which is always present in our minds. The violence of scientific attacks upon Gall and his repeated return to popular favor spring from the same psychological source. But we might also ask ourselves whether the phrenological theory does not develop an obvious parascientific truth.

Having jettisoned the whole of Gall's demonstrative apparatus, which is completely without foundation, we are left with several assertions that are not lacking in value at their starting point. Gall defended the specialization of different areas of the brain; this today is a commonplace fact. He claimed that each organ finds extension in the nervous system all the way to the cerebral cortex; this is at present recognized. He believed that many psychological traits are conditioned by the individual's physical constitution; this is also an unassailable view. We are free to choose whether to regard him as a madman or a forerunner. His work, like N. de Maillet's in the mideighteenth century, appears ridiculous and scientifically useless today, but he was a man of large-scale ideas and penetrating insights. It can be said of all those who embark upon the adventure of science that in their intuitive perception of a connection between facts of two different orders, they are obliged to resort to demonstrative methods that are generally childish in nature: The same reproach can be addressed to the pioneers of evolutionism or of human paleontology.

9. The legend of the "apophysis *geni*" offers a good example of wanting to explain everything with what happens to be available, however little that may be. The apophysis *geni* is a formation on the inner surface of the chin into which the genioglossal muscle, one of the muscles that activates the tongue, is inserted. The manner in which insertion of the muscle is achieved varies a good deal from one mammal to another, but whereas the apophysis *geni* is found only in anthropoids, the genioglossal muscle itself plays a most important role in the mobility of the tongue in, for instance, ruminants. Apophyses *geni* in anthropoids are subject to considerable individual variation; some Palaeoanthropian mandibles show more developed ones than others; in the La Naulette jaw found in 1866, they are small. This Palaeoanthropian mandible, the only one known at the time, provided the basis for the theory of language that G. de Mortillet advanced in *Le Préhistorique,* 1883, p. 250, in the following surprising terms:

> *All men, even the most inferior, possess the power of speech, but was this always so?*
> *The La Naulette jaw says: No!*

Having thus obtained a declaration from the speechless jaw, the author adds: "Articulated speech is produced by a series of movements of the tongue. These movements are effected principally by a muscle inserted in the apophysis *geni.* In animals incapable of speech, the apophysis *geni* is lacking. The fact that it is also lacking from the jaw of La Naulette means therefore that Neanderthal man, Chellean man, was bereft of the power of speech. . . ."

One is at a loss what to admire more—the sleight of hand whereby the apophysis *geni* becomes the necessary and sufficient precondition for speech, the author's absolute contempt for the laws of phonation (which by 1880 were known well enough), or the paradox which—since the genioglosses forms the major part of the lingual muscle—ends up by denying the chimpanzee or the cow the possession of the organ of a tongue. The unconcern with which the man to whom we owe the first rational classification of prehistoric periods flies in the face of his own system by equating Neanderthal man with Chellean man is no less surprising.

10. A theory on the simultaneous development of techniques and language has been put forward by the Russian anthropologist V. V. Bounak in terms not unlike those I am proposing. However, this theory is based on very general technological data and attempts to reconstitute the stages from sound signals to grammatically constructed language. It is particularly interesting to note that the entirely different approach adopted here, which is based on the integration of the gesture with the phonic symbol, leads to relatively similar results. (See Bounak 1958.)

11. The word *primitive* is employed here to designate the technoeconomic condition of the earliest human groups, that is to say, exploitation of the natural environment in its wild state. The term thus covers all prehistoric societies preceding agriculture and animal husbandry and, by extension, the very few societies whose primitive state has maintained itself throughout history until the present day. Ethnologists have for a long time been critical of this term, which is continually contradicted by social, religious, or aesthetic facts, and for that reason "primitive" has taken on pejorative overtones. But they have not abandoned the term. No other term has been found to designate all peoples who have no writing and have stood aside from the so-called great civilizations. Quotation marks are, however, employed in most cases. In the present context the meaning is precise and well-founded: The term is not applicable to any group whose economy is based on artificial exploitation of the natural environment, and it also reflects certain common characteristics particular to groups that subsist exclusively by hunting, fishing, and plant gathering.

12. The emergence or adoption of animal husbandry is connected with the overlapping of two systems of values: the biological and biogeographical characteristics of the species bred and the technoeconomic level of the breeder. Biological characteristics explain why the dog, a game-scenting and game-raising animal, was domesticated in preference to felines, which as game-stalkers are of no use to humans in this exercise. The same is true of Cervidae, which scatter when pursued, as opposed to Bovidae which stay together and can therefore be herded. Geographical

characteristics are important when we compare the brief period of migration to a higher altitude required by herds of Lapland reindeer with the immense latitude of migrations of American caribou. The role of the technoeconomic system is noticeable, for example, in the case of reindeer, which are bred differently by the Chukchis—who are actually proto-breeders—and by the Tungus or the Southern Lapps, real breeders influenced by the proximity of Siberian or Scandinavian farmers. The very small number of species used shows that the preconditions for stockbreeding are strict, that animal husbandry sprang up spontaneously in only very few places, and that only some well-determined kinds of animals are eligible.

13. For purposes of agricultural economics, animal husbandry can be subdivided as follows:

A. *Connection between the breeder and an animal in its natural biotope and with its natural behavior.* This is the *proto-breeding* situation, with plant gathering and hunting still playing a very important role, and today it is confined to a few groups of reindeer breeders in Eastern Siberia.

B. *Connection between the animal and a nomadic breeder in symbiosis with agricultural communities.* This is *pastoral stock-breeding*—with oxen, sheep, and camels as the predominant species and donkeys, horses, and goats as associated ones—and it is confined to the grassy plains of the Old World. It implies a farmer-stockbreeder symbiosis between two distinct, normally exogamous ethnic groups (Turks, Mongolians, Touareg, Peuls, Saracatsans of Eastern Europe).

C. *Connection between the animal and a sedentary breeder:*

a. *Semipastoral breeding.* The animal is kept in a large collectivity (herd). The specialist herder is secreted by the agricultural society, either temporarily or permanently (Malagasy, the Massa of Chad, Alpine and Pyrenean herdsmen and shepherds, American cowboys or gauchos).

b. *Agricultural stockbreeding.* The animals are kept in small collectivities. Specialists in supervising the animals within the perimeter of the farm (cowherds, shepherds) are partially assisted by the family (children, old people). This is the most widespread form of European animal husbandry but is also common in many societies outside Europe.

c. *Agricultural domestication.* Animals kept singly or in a very small collectivity. The animal is integrated within the domestic system and fulfills the function of a technical implement (oxen, donkeys, and horses in many societies of Eurasia and Africa north of Chad).

Part II

14. In this book the term "memory" is used in a very broad sense. It is not a property of the intelligence, but, whatever its nature, it certainly serves as the medium for action sequences. That being so, we can speak of a "species-related memory" in connection with the establishment of behavior patterns in animal species, of an "ethnic" memory that ensures the reproduction of behavior patterns in human societies, and similarly of an "artificial" memory in its most recent form that—without referring to either instinct or thought—ensures the reproduction of sequences of mechanical actions.

15. This fact is as true of, and as important in, primitive societies where children and adolescents form a potentially isolated social group, with young people cohabiting separately, as in modern societies where school is perceived as a powerful means of shaping behavior. The ideological aspects of education tend to make us overlook the operational aspects, although these constitute a fundamental part of the collective personality. Ideological indoctrination, if it is to be total, must rely on elementary operating behavior; educational programs aimed at turning out individuals ideally in conformity with the collective ideal—from the Spartans to the British public school or the socialist educational system—have always included the creation of mechanical action sequences. The humorous example of the Englishman dressing for dinner alone in the jungle provides a good illustration of the personalizing manner in which elementary sequences work at both the individual and the ethnic levels.

16. In mammals the relative proportions of labiodental and lateral or bilateral manual grasping vary a great deal. They are governed not only by the degree of freeing of the anterior limbs but also by the degree of development of the motor cortex and by the manner of food acquisition. In the rabbit, despite the animal's seated posture, manual grasping is nonexistent; in the agouti it succeeds labiodental grasping, the manual action being bilateral and confined to holding the food. In rodents with a highly developed grasping ability such as the beaver, the marmot, the hamster, the squirrel, or the rat, labiodental grasping when seated leads immediately to coordinated action with both "hands," which are sufficiently independent to be able to turn the object so as to present it conveniently to the teeth. Primary use of the hands in order to seize the object is observed, even if rarely. In grasping carnivores such as felines, lateral or bilateral manual grasping alternates with labiodental grasping depending on the action involved. Bilateral manual grasping predominates when the prey is captured by pouncing; when it is seized in a stationary or tripedal seated position, lateral manual grasping is dominant. In eating, olfactory recognition is connected with labiodental grasping in a crouching quadrupedal position. In the bear, in plantigrade Mustelidae such as the badger, or in Procyonidae such as the raccoon, for which locomotion in trees plays an important role, the pattern, while similar to that observed in felines, is more subtly differentiated and already close to that of primates: The bear can pluck an object with one hand, carry it to the nose for recognition, and then grasp it secondarily between the lips for eating, both hands being used to assist the operation. In monkeys, although the precise proportions vary considerably from one species to another, manual action (often lateral) is primary and labiodental action secondary, as in humans.

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