The Biological Nature of Man

The answer to the ancient question "What is man?" must be based first on man's biological character.

George Gaylord Simpson

It has often and confidently been asserted, that man's origin can never be known: but ignorance more frequently begets confidence than does knowledge: it is those who know little, and not those who know much, who so positively assert that this or that problem will never be solved by science. (*1*)

Those words were written by Charles Darwin nearly 100 years ago and were published in 1871 in the introduction to his book on *The Descent of Man*. In his even better known work on *The Origin of Species* (*2*), which had appeared 12 years earlier, he had been content to say (somewhat coyly) that by that work "light would be thrown on the origin of man and his history." Others soon indicated the nature of that light. Thomas Henry Huxley's classic *Man's Place in Nature* (*3*) was published in 1863, and by 1871 numerous other naturalists of the first rank had already accepted the evolutionary origin of the human species. Darwin's own contribution to the problem of man's origin firmly established two points: first, *Homo sapiens*, like all other organisms, has evolved from prior, extremely different species by natural means and under the directive influence of natural selection; and second, man is the descendant of apes or monkeys of the Old World.

Darwin's first point, that man is the product of evolution involving natural selection, has been attacked on emotional grounds, but it was not and is not now honestly questionable on strictly scientific grounds and by anyone really familiar with the facts. The second point, of man's descent from an Old World ape or monkey, was for some time more open to scientific dispute. However, here, too, the debate was often more emotional than objective. In some pedagogic circles it became usual to maintain that man is not descended from an ape but from a common ancestor neither man nor ape nor, if one cared to go still further afield, monkey. Some went so far as to attempt to enlist Darwin posthumously in their own pussyfooting ranks by saying that he never maintained that man arose from an ape but only from a common ancestor . . . and so forth. In fact, although Darwin was slow to enter the dispute, when he did so he was more honest than those supposed defenders. He flatly said, "We must conclude, however much the conclusion may revolt our pride, that our early progenitors would have been properly . . . designated [as apes or monkeys]." The unscientific and really uncalled-for remark on pride does little to modify the forthrightness of the conclusion.

Darwin's conclusions in 1871 already covered what is most vital for consideration of man's biological status. Subsequent discovery and study have fully corroborated Darwin and have added an enormous amount of detail. That is interesting and important, and most of what I have to say here concerns it. At this point, however, the essential thing is that Darwin put the whole subject of the nature of man on a new and sound footing. To be sure, in the introduction of *The Descent of Man*, from which I have already quoted, Darwin went on to say that, "The conclusion that man is the co-descendant with other species of some ancient, lower, and extinct form, is not in any degree new." He then cited Lamarck, Wallace, Huxley, Lyell, Vogt, Lubbock, Büchner, Rolle, Haeckel, Canestrini, and Barrago as "having taken the same side of the question." In fact, as regards this particular point, Darwin was doing too much honor to those worthies, some still famous and some now forgotten. It is true that they had all discussed the descent of man before Darwin himself did so in an explicit way, but with the sole exception of Lamarck they had done so after publication of *The Origin of Species* and on the basis of that work by Darwin. As for the few who really had postulated an evolutionary origin for man before *The Origin of Species*, their views were largely philosophical speculations inadequately or not at all supported by objective evidence and sometimes, as in the case of Lamarck, reaching a conclusion only approximately correct on grounds that were flatly wrong (*4*).

What Is Man?

The question "What is man?" is probably the most profound that can be asked by man. It has always been central to any system of philosophy or of theology. We know that it was being asked by the most learned humans 2000 years ago, and it is just possible that it was being asked by the most brilliant australopithecines 2 million years ago. The point I want to make now is that all attempts to answer that question before 1859 are worthless and that we will be better off if we ignore them completely. The reason is that no answer had a solid, objective base until it was recognized that man is the product of evolution from primeval apes and before that through billions of years of gradual but protean change from some spontaneously, that is, naturally, generated primordial monad.

It is the biological nature of man, both in his evolutionary history and in his present condition, that presents us with our only fixed point of departure. These are the facts we can find out for ourselves, in great, ever-increasing detail and soundness, open to all of us in irrefutable observations. Their interpretation is in some respects ambiguous and disputable, but interpretation at a given point becomes increasingly clear and undisputed as time goes on. Doubtfulness moves outward with the expanding frontier of knowledge.

I do not mean to say that the biological study of man or even that

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the scientific study of man in terms broader than biological can here and now—if ever—provide a satisfactorily complete answer to the question "What is man?" The other, older approaches through metaphysics, theology, art, and other nonbiological, nonscientific fields can still contribute, or can now contribute anew. But unless they accept, by specification or by implication, the nature of man as a biological organism, they are merely fictional fancies or falsities, however interesting they may be in those nonfactual categories. I am here concerned with man's biological nature in a rather broad sense, on the grounds that this is a necessary, even though it is not a completely sufficient, approach to comprehension of man's nature.

Already in Darwin's day it was clearly established that among living animals the great apes are anatomically most similar to man. Some anatomists, reluctant to acknowledge their poor relatives, stressed differences between man and any apes: the larger human brain, obviously; the longer and less divergent first toe of man; the absence or, more commonly, the only-sporadic presence in us of certain apish muscles and other structures. Such discussions completely missed the point. Of course men and apes differ. In itself, that means only that we belong to different species. The point at issue is not whether we differ, but in what way and how closely the different species are related.

All later study has corroborated the special relationship between men and apes and has made knowledge of it more precise. The evidence has lately been greatly increased in extent, in detail, and in its basic character. It now includes such fundamental points as the numbers and shapes of chromosomes, the exact molecular structure of hemoglobins, the resemblances and differences of serum proteins, and many others (*5*). All the evidence agrees and the conclusion is unequivocal. Man is not identical with apes in these or other respects. However, he is clearly related to the apes, and among the apes he is most particularly related to chimpanzees and gorillas, which are closely related between themselves. A necessary inference from this evidence is that the common ancestor of apes and men was itself a member of the ape family. Not only that; we had a common ancestor with gorilla and chimpanzee after their ancestry had become distinct from that of the other living apes (orangutan and gibbons). Our relationships to gorilla and to chimpanzee are about equal, although gorillas may have become somewhat more specialized with respect to the common ancestry.

Evidence from Fossils

More precise evidence as to relationships and as to the course of anatomical change in the human ancestry must come from fossils. There are special reasons why pertinent fossils are comparatively uncommon: Crucial stages apparently occurred in the tropics, where preservation and discovery of fossils are difficult and where exploration has generally lagged; populations of apes and of pre-humans were always small, not at all comparable with the great herds of grazing animals, for example, common as fossils; and the habits and abilities of apes and pre-humans were such as to reduce chances of natural burial and preservation as fossils.

Nevertheless, a great many fossils have been recovered and discovery is active at present. We are far from having the whole story, but parts of it are increasingly clear.

In Darwin's time only one really distinctive kind of fossil ape (*Dryopithecus*) and only one really distinctive kind of fossil man (Neandertal) were known. From the former, Darwin correctly inferred that by late Miocene, at least, the lineages of apes and monkeys had separated. He was not clear as to the possible implications for separation of the strictly human lineage, which he thought might have occurred much earlier. As regards Neandertal man Darwin could only express surprise that in spite of their antiquity the Neandertals had brain capacities probably greater than the average for modern man.

Now it is known that apes more or less similar to *Dryopithecus* were widespread and, as apes go, numerous through the Miocene and Pliocene of Europe, Asia, and Africa (*6*). Present estimates place the beginning of the Miocene at approximately 25 million years ago (*7*). The divergence of apes and Old World monkeys is thus at least that old. There is, in fact, some evidence that this divergence occurred in the Oligocene, which preceded the Miocene and began some 10 million years earlier. Divergence of apes and monkeys was identical with divergence of the human ancestry and monkeys, because the earliest apes were also ancestral to man. The time of the final split of the specifically prehuman lineage from that leading to gorilla and chimpanzee has not yet been closely determined. On present evidence it seems most likely to have occurred during the Miocene, that is, quite roughly between 10 and 25 million years ago. The earliest known forms that may be definitely on a prehuman line as distinct from a pre-gorilla-chimpanzee line are *Ramapithecus* from India and the closely similar, indeed probably identical supposed genus *Kenyapithecus* from Africa (*8*). Unfortunately those animals are known only from teeth and fragments of jaws, so that their affinities are somewhat uncertain and the anatomy of their skulls and skeletons is entirely unknown. The known specimens are approximately 10 million years old, give or take a few million.

The next significant group of fossils is that of the australopithecines, literally "southern monkeys" although they almost certainly were not exclusively southern and with complete certainty were not monkeys. They are surely and comparatively well known from East and Souh Africa, doubtfully and, at best, poorly known from elsewhere in Africa and from Eurasia. In Africa they are clearly divisible into two distinct groups. There is dispute as to whether those groups should not be subdivided still further and whether they should be called species or genera. Although the specialists can become enraged over those questions, they have no real importance for others, the important fact being simply that the two separate groups did exist, a point on which even the specialists now agree. Both groups resemble apes much more than we do now, but both are more nearly related to us than to the apes—another point on which the specialists have finally agreed after years of wrangling. They definitely belong to the human family, Hominidae.

One group, typified by *Australopithecus robustus* or, as it is also often called, *Paranthropus robustus*, retained some particularly primitive (more or less apelike) features and yet became somewhat aberrantly specialized. It cannot have been directly ancestral to modern man. The other

group, typified by *Australopithecus africanus*, although also primitive within the human family, more closely resembles our own genus, *Homo*. Both groups are now believed to have appeared at least 2 million years ago. For a long time, perhaps 1½ million years, there were at least two distinct lineages of the human family living in Africa and probably throughout the warmer parts of the Old World. One, more primitive and aberrant, showed little progress and finally became extinct. The other, more progressive, evolved into *Homo*. A matter still under sharp dispute is whether the latter lineage included *Australopithecus africanus* as our direct ancestor, or whether for a time there were not actually three distinct lines: the two kinds of australopithecines and still another more directly related to *Homo*. The latter suggestion arises from Leakey's discovery of what he calls *Homo habilis* (*9*). However, some authorities believe that supposed species not to be on a distinct lineage but to belong to the line leading from *Australopithecus africanus* eventually to *Homo sapiens*.

That dispute is interesting and we hope it may soon be settled, but it is far less important than the fact that our ancestry passed through a stage closely similar to *Australopithecus africanus* if it was not that group itself. Our ancestors were then fully bipedal, ground-living animals, using their hands for manipulation as we do but perhaps not quite so skillfully. Their teeth were so like ours as to be hard to distinguish, but their brains were little larger than those of apes, and if we could see them alive their physiognomy, while distinctive, would probably strike us as more apelike than manlike.

By a time probably not later than 500,000 years ago and perhaps earlier, gradual evolution from australopithecines had reached a stage that was human in a more restricted sense, belonging not only to the human family, Hominidae, but also to the same genus as ourselves, *Homo*. Doting and ambitious discoverers have given many different names to such early fossil men, including *Pithecanthropus* and *Sinanthropus*, but most of them are now usually placed in a single species, *Homo erectus*. Bodily anatomy and even physiognomy were now almost fully human, but to our eyes there was still a coarse or brutish cast of countenance because of heavy brow ridges over the eyes and a low, small brain case. The brain size was neatly intermediate between australopithecines (or modern apes) and modern man.

Finally, and still gradually, our own species, *Homo sapiens*, emerged. Although not entirely certain, it is now the usual opinion that the quite varied fossils known collectively as Neandertal men belonged to *Homo sapiens* and only represent ancient races that were at first primitive (not so far removed from *Homo erectus*) and later somewhat aberrant. The more aberrant late Neandertals became extinct as such, although it is probable that some of their genes survive.

So much for more or less direct knowledge of man's physical, anatomical origin. The main points are these:

1) Man evolved from apes also ancestral to chimpanzees and gorillas, but less specialized than the latter.

2) The divergence of man's ancestry from the apes was early marked by bipedalism and upright posture, with extensive correlations and implications in anatomy, habits, and capabilities.

3) Also early was divergent dental evolution, again with other implications, for example as to diet and means of defense. It is not known whether posture and dentition diverged from the apes simultaneously or in which order.

4) Only after evolution of human posture and dentition was essentially complete did man's brain begin to enlarge beyond that of the apes. (Intelligence depends not only on size of the brain but also on its internal anatomy, and we do not know the internal anatomy of our fossil ancestors' brains. However, it is fairly certain that a species with average brain size as in apes could not be as intelligent as *Homo sapiens*.)

Systematics of Modern Man

Now let us briefly consider the taxonomic, biological systematic nature of mankind as it exists today. First and most important is the fact that mankind *is* a kind, a definite and single species. A biological species is an evolutionary unit composed of continuing populations that regularly interchange genes by interbreeding and that do not or cannot have such regular interchange with other species (*10*). The definition clearly applies to mankind: all human populations can and, as opportunity occurs, do interbreed, producing fertile offspring and thus continuing the species and keeping it bound together as a unit. It is unlikely that, for example, a Greenland Eskimo has ever interbred with a South African Bushman, but since all intervening populations can and do interbreed they are nevertheless members of the same species. That species, *Homo sapiens*, is not connected with any other species by interbreeding.

Comparison of Eskimo and Bushman brings up the obvious (although occasionally denied) fact that the human species includes quite diverse races. A race is simply a population (or group of populations) that is genetically distinguished from others. The distinction is not absolute. It is unlikely that Negroes, for example, have any genes that do not occur in some white populations, or that whites have any genes absent in all Negro populations. The usual situation is that a race has certain genes and gene combinations that are more frequent in it than elsewhere, and therefore typical in that sense, but not confined to the race. Races always grade into each other without definite boundaries. There is not now and never has been such a thing as a pure race, biologically speaking. Any two human populations, no matter how small or how large, differ in some respects, so that there is no fixed number of races. One could count thousands or two, and no matter how many are counted, there will be some populations and many individuals that do not clearly fit into one or another. Moreover, races are evanescent in the course of evolution. A given race may change, disappear by fusion with others, or die out altogether while the species as a whole simply continues its evolutionary course (*11*).

Races of man have, or perhaps one should say "had," exactly the same biological significance as the subspecies of other species of mammals. Widespread animals have local populations that live under diverse conditions and that may become temporarily and in part isolated from each other. They may then more or less accidentally have different proportions of genes (in stricter technical language, of alleles) from other such populations, and if the situation continues long enough, they will almost inevitably evolve somewhat different adaptations to local conditions. Primitive men were relatively few in number and relatively immobile, but they spread over enormous areas—the whole land area of the earth except for Antarctica and a few small islands. They evolved into races or, in better biological terms, into subspecies exactly as any other animal would have under

those circumstances. Racial differentiation in man was originally geographic and, for the most part, adaptive.

That was the original biological significance of race. One must say that Negroes were biologically superior to whites, if reference is to prehistoric times, when the races were originating, and to African conditions, to which Negroes were biologically adapted and whites were not. At the present time race has virtually no strictly biological significance because of two crucial changes. First, human adaptation to different environments is now mostly cultural and is directly biological only in lesser part, so that the prehistoric biological adaptations have lost much of their importance. Second, tremendous increases in population size, in mobility, and in environmental changes brought about by man himself have the result that extremely few men are now living under the conditions to which their ancestors were racially adapted.

Evolution does not necessarily proceed at the same rate in different populations, so that among many groups of animals it is possible to find some species that have evolved more slowly, hence are now more primitive, as regards some particular trait or even over-all. It is natural to ask—as many have asked—whether among human races there may not similarly be some that are more primitive in one way or another or in general. It is indeed possible to find single characteristics that are probably more advanced or more primitive in one race than in another. For example, the full lips and kinky hair of some Negroes are almost certainly progressive traits in comparison with the more primitive, decidedly apelike thin lips and straight hair of most whites. However, that does not mean that whites in general are more primitive than Negroes or otherwise inferior to them. Overall primitiveness and progressiveness in comparison of different groups of animals is practically confined to cases in which the groups are of different species, so that genes of the more rapidly evolving species cannot be transferred to the lagging species. Human races all belong to the same species and have generally had enough interbreeding so that genetic progress, as distinct from local adaptation, could and evidently did spread through the entire species. Only if some race entirely ceased to interbreed with any other would it be likely for it to fall behind and become definitely inferior. Let us hope that will not happen.

Resemblances, Anatomical and Psychological

Regardless of the diversity of races, it is obvious that all men resemble one another much more than any of them differ from each other. They all share the basic qualities, anatomical, physiological and psychological, that make us human, *Homo sapiens*, and no other species that is or ever was. Something has already been said of anatomical peculiarities of *Homo sapiens* with respect to living apes and human ancestors. Here are some of the most striking human anatomical traits:

Normal posture is upright.

Legs are longer than arms.

Toes are short, the first toe frequently longest and not divergent.

The vertebral column has an *S* curve.

The hands are prehensile, with a large and strongly opposable thumb.

Most of the body is bare or has only short, sparse, inconspicuous hair.

The joint for the neck is in the middle of the base of the skull.

The brain is uniquely large in proportion to the body and has a particularly large and complex cerebrum.

The face is short, almost vertical under the front of the brain.

The jaws are short, with a rounded dental arch.

The canine teeth are usually no larger than the premolars, and there are normally no gaps in front of or behind the canines.

The first lower premolar is like the second, and the structure of the teeth in general is somewhat distinctive.

Given those characteristics, a museum curator could readily identify any specimen of *Homo sapiens* that was added to the collections, or that happened to walk into his office. However, we who are pondering the question "What is man?" must feel that these anatomical features, fully diagnostic as they are, yet do not amount to an answer adequate for our purposes. Even if we were defining, say, a species of mouse, the anatomical definition would not take us far toward understanding "What is mouse?" or, better, "What is mouseness?" unless we related the bodily mouse to the behaving mouse and the thinking mouse. Even thus, human anatomy reflects truly essential man-ness or human nature only to the extent that it is related to human activities and psychology. Already in *The Descent of Man* (*1*) Darwin discussed such traits in which man appears to be most distinctive. His points, here greatly abbreviated and paraphrased, were as follows:

In proportion with his higher intelligence, man's behavior is more flexible, less reflex or instinctive.

Man shares such complex factors as curiosity, imitation, attention, memory, and imagination with other relatively advanced animals, but has them in higher degree and applies them in more intricate ways.

More, at least, than other animals, man reasons and improves the adaptive nature of his behavior in rational ways.

Man regularly both uses and makes tools in great variety.

Man is self-conscious; he reflects on his past, future, life, death, and so forth.

Man makes mental abstractions and develops a related symbolism; the most essential and complexly developed outcome of these capacities is language.

Some men have a sense of beauty.

Most men have a religious sense, taking that term broadly to include awe, superstition, belief in the animistic, supernatural, or spiritual.

Normal men have a moral sense; in later terms, man ethicizes.

Man is a cultural and social animal and has developed cultures and societies unique in kind and in complexity.

The last point, which some students now consider the most important of all, was least emphasized by Darwin, who was here mainly concerned with the relationship of social evolution to the origin of the moral sense. Darwin's general purpose was not to characterize *Homo sapiens* as the unique species that he is. The purpose was to show that the characteristics that make him unique are nevertheless foreshadowed in other animals, and that the evolution of man from other, earlier, quite distinct species is therefore plausible. We are no longer concerned with *whether* man evolved, because we know that he did. We are still very much concerned with *how* he evolved, with what is most characteristically human about him and how those characteristics arose. The list of traits discussed by Darwin is still valid from this somewhat different point of view.

That list should not be taken as involving so many separate and distinct things. These are aspects of the behavior, capacities, and accomplishments of a species that is characterized by all of them together and not by each or any one separately. They interact and interlock not only with each other but

also with the previously mentioned physical or anatomical characteristics of man. For example, complex human societies, especially the modern industrial civilization rapidly spreading to the whole world, require specialization of activities by different members of society further involving manipulation of complex machines. Such specialization, which is nongenetic, requires individual flexibility and could not occur in a mainly instinctive animal. The machines are tools and could only have been devised by a reasoning, tool-making animal. Invention also required manual deftness, which was provided by (and which also gave selective value to) the structure of the human hand, which required upright posture and could not have been acquired by a quadruped. Further evolution of the early cultural adaptations that led eventually to modern industry also had increased intelligence as a necessary concomitant, and that eventually required larger brains, which in turn involved change in skull structure and in stance —and so on. Even the changing pattern of the teeth can be related to this unitary complex.

The Major Evolutionary Changes

Because all the specifically human traits are integrated within the whole that is human, and because each of the traits as well as their integration must have arisen gradually, it is somewhat questionable to speak of definite milestones or even of particular critical phases in the evolution of man. Yet there are three among these slow and coordinated changes that seem particularly basic for the concept of human-ness. The most crucial single anatomical point is acquisition of upright posture and strictly bipedal locomotion. Most of the other main peculiarities of human anatomy either follow from that or are coadapted with it. The other two major factors are cultural, but are no less biological since both represent attainment and maintenance of biological adaptation by cultural means. They are tool making and language.

Extremely crude but unmistakable stone tools are found in the oldest rock strata containing indisputable members of the human family, nearly, if not quite, 2 million years old. It will be difficult to authenticate still older and more primitive stone tools, because they must have consisted of natural pebbles or rock fragments picked up and used with little or no modification. It has long been maintained that deliberate manufacture of a tool is the distinctive human trait, since many other animals, even including some insects, use natural objects as tools but do not make tools. Now it has been found that chimpanzees may trim and shorten twigs or straws for use as tools (*12*), and although that simple behavior is almost too primitive to be called tool making, it sufficiently demonstrates that the capacity for tool making is biologically ancient and prehuman. If one wants a more diagnostic statement, it probably is true that man is the only living animal that uses tools to make tools. However, that trait would follow soon and inevitably once tool making really got under way. A stone used to knock flakes off an incipient stone ax is already a machine tool.

Ancient tools more perishable than stone are rarely preserved. Nevertheless, the course of increasing diversity and complication of tools can be followed well enough to demonstrate the gradual and inconstant but generally continual progress through prehistory. The tremendously accelerated progress in historic times is very well documented and is familiar to all of us in general outline, at least. The whole sweep from stone axes to electronic computers is a natural and comprehensible extension of the biological capacities of an unusual species. It is uniquely wonderful, and yet, lest we stand too much in awe of our own products, let us remember that a digital computer is merely a rapid and automated tool for what amounts to counting on fingers.

As posture is focal for consideration of man's anatomical nature and tools are for consideration of his material culture, so is language focal for his mental nature and his non-material culture (*13*). Language is also the most diagnostic single trait of man: all normal men have language; no other now-living organisms do. That real, incomparably important, and absolute distinction has been blurred by imprecise use of the word "language" not only in popular speech but also by some scientists who should know better, speaking, for example, of the "language of the bees" (*14*).

In any animal societies, and indeed in still simpler forms of aggregation among animals, there must be some kind of communication in the very broadest sense. One animal must receive some kind of information about another animal. That information may be conveyed by specific signals, which may be of extremely diverse kinds both as to form and as to modality, that is, the sensory mode by which it is received. The odor of an ant, the movements of a bee, the color pattern of a bird, the howl of a wolf, and many thousands of others are all signals that convey information to other animals and that, in these and many other examples, are essential adaptations for behavioral integration in the species involved.

Human language is also a system of interpersonal communication and a behavioral adaptation essential for the human form of socialization. Yet human language is absolutely distinct from any system of communication in other animals. That is made most clear by comparison with other animal utterances, which most nearly resemble human speech and are most often called "speech." Nonhuman vocables are, in effect, interjections. They reflect the individual's physical or, more frequently, emotional state. They do not, as true language does, name, discuss, abstract, or symbolize. They are what the psychologists call affective; such purely affective so-called languages are systems of emotional signals and not discourse. The difference between animal interjection and human language is the difference between saying "Ouch!" and saying "Fire is hot."

That example shows that the non-language of animal interjection is still present in man. In us it is in effect not a part of language, but the negative of language, something we use in place of speech. In part we even use the same signals as do the apes, a fact already explored to some depth by Darwin in another of his basic works, *The Expression of the Emotions in Man and Animals* (*15*). Much more is now known about such expressions in animals, and particularly in our closer relatives the apes and monkeys, and it is not surprising to find that the non-linguistic, affective system is particularly complicated in them and has not progressed but may even have retrogressed in man. Still we do retain that older system along with our wholly new and wholly distinct system of true language. It is amusing that the human affective interjectional reaction to a bad smell is practically the same as in all other primates, down even to the most primitive.

Attempts To Trace Language

Darwin's study and many later studies sought to trace the evolutionary origin of language from a prehuman source. They have not been successful. As a recent expert in the field (*16*) has said, "The more that is known about it [that is, communication in monkeys and apes], the less these systems seem to help in the understanding of human language."

Many other attempts have been made to determine the evolutionary origin of language, and all have failed. Because language is so important for any concept of man and because this is an interesting example of methodology and limitations, it is worthwhile to consider some of these futile attempts. One, fairly obvious once the idea of linguistic evolution had arisen, was by comparison of living languages. One result was a supposed genetic sequence: (i) isolating languages, like Chinese, which string together invariable word roots; (ii) agglutinating languages, like Mongolian, which modify roots by tacking on prefixes and suffixes; and (iii) flexional languages, like Latin, which modify by (partly) internal changes in words. The trouble is that these categories are not really distinct and, especially, that they did not historically occur in this sequence. For example, Chinese was probably flexional at one time and is now becoming agglutinating with a possibility of becoming flexional again. English was flexional until quite recently and is now mostly isolating with a strong dash of agglutination. Moreover at the present time no languages are primitive in the sense of being significantly close to the origin of language. Even the peoples with least complex cultures have highly sophisticated languages, with complex grammar and large vocabularies, capable of naming and discussing anything that occurs in the sphere occupied by their speakers. Tales of tribal natives who cannot count beyond 4 and who have vocabularies of only two or three hundred words betray the shortcomings of gullible travelers, not of the natives (*17*).

Another approach is to follow back directly historical records, which cover several thousand years for some European, Asiatic, and north African languages. It is then possible to project still further and to reconstruct, for example, a proto-Indo-European anterior to Sanskrit. But this still leaves us tens or hundreds of thousands of years—perhaps even more—from the origin of language. The oldest language that can reasonably be reconstructed is already modern, sophisticated, complete from an evolutionary point of view.

Still another attempt, which now seems very naive, is through the ontogeny of language, that is, the acquisition of language by children. This relies on the famous but, as it happens, quite erroneous saying that ontogeny repeats phylogeny. In fact the child is not evolving or inventing primitive language but is learning a particular modern language, already complete and unrecognizably different from any possible primitive language. Moreover, the child is doing this with a modern brain already genetically constructed (through the long, long action of natural selection) for the use of complete, wholly nonprimitive language.

It is a tempting hypothesis that the time, at least, of the origin of language might be determined by structural characteristics in fossils. One rather elaborate attempt departed from the fact that all linguistic phonetic systems, varied as they are, depend in part on the shape of the lower jaw and the hard palate, anatomically quite different in typical members of the human and the ape families. It was postulated that speech began when these anatomical parts reached human form, which was in the australopithecines or somewhat earlier. But the postulate is clearly wrong. Audible signals capable of expressing language do not require any particular phonetic apparatus, but only the ability to produce sound, any sound at all. Almost all mammals and a great number of other animals can do that. Moreover, a number of animals, not only birds but also some mammals, can produce sounds recognizably similar to those of human language, and yet their jaws and palates are radically nonhuman. A parrot is capable of articulating a human word but is completely incapable of understanding what the word means.

Given any method of sound production, the capacity for language depends not on characteristics of the sound apparatus but on the central nervous system. Speech is particularly connected with the left temporal lobe of the human brain, as shown, for example, by the fact that ability to speak is generally lost if that lobe is severely damaged. The gross development of the lobe can be seen in plaster casts of the insides of fossil skulls, and that, too, has been proposed as a means of determining whether or not a given fossil individual could speak. But all mammals have left temporal lobes, some smaller and some larger. Those with smaller lobes do not speak just a little and those with larger lobes more. There is no graded sequence: normal men speak completely; other animals, whatever the relative size of their temporal lobes, do not speak at all.

The essential anatomical and physiological basis of speech is nevertheless in the structure and function of the brain (*18*). That basis is not fully known, but it evidently involves not just a language center, such as might be localized in the temporal lobe, but an intricate and widespread system of associative connections throughout much of the brain. (The nature or presence of these connections cannot be determined in fossils.) Thus sensations of any kind derived from an external object or event can be generalized according to similarities with others. Each kind can then be associated with a distinctive symbol, which does not resemble the object or event at all but which arbitrarily stands for it. That symbol, a supreme element in the nature of man, is the word, and it is not surprising that words meaning "word," abstraction and symbolization on still another level, have acquired such mystical and philosophical overtones. (Λόγος!)

It is still possible but it is unlikely that we will ever know just when and how our ancestors began to speak. Yet it is certain that this ability depends on physical, structural, and chemical characteristics of the nervous system which evolved from our nonspeaking ancestors under the force of natural selection. The capacity for this unique kind of symbolization is quite general. It does not determine what symbol will be used for a given concept, but that any symbol can be associated with any concept. Thus we are all using exactly the same genetic capacity and symbolizing the same concept when various of us say "woman," "Weib," "femme," "mujer," "zhenshchina," or "imra," depending on whether we happen to have been raised in England, Germany, France, Spain, Russia, or Egypt. The words do not resemble each other and even less resemble the concept they stand for. Moreover, they can be written in different ways, as in Latin, Arabic, or Chinese characters, that do not resemble each other and that have no

physical resemblance to the spoken words. They can even be associated with some symbol that is not verbal at all, as in this example with the simplified representation of Venus's mirror that biologists use to designate females: ♀.

Conclusion

Language has become far more than a means of communication in man. It is also one of the principal (although far from the only) means of thought, memory, introspection, problem-solving, and all other mental activities. The uniqueness and generality of human symbolization have given our mental activities not only a scope but also a quality far outside the range of other animals. It keeps us aware, to greater extent than can otherwise be, of past and future, of the continuity of existence and its extension beyond what is immediately sensed. Along with other peculiarly human capacities, it is involved in what I consider the most important human characteristic from an ethical point of view: foresight. It is the capacity to predict the outcome of our own actions that makes us responsible for them and that therefore makes ethical judgment of them both possible and necessary (*19*).

Above the individual level, language and related powers of symbolization make possible the acquisition, sharing, and preserving of knowledge far beyond what would be possible for any single individual. That is an indispensable element in all forms of human social organization and cultural accomplishment, even the most primitive.

It is obvious that I have by no means touched on all aspects of the biological nature of man. That would be impossible in one essay by one author. Those familiar with recent developments in biology may particularly miss reference to molecular biology and especially to the compound called DNA, now known to be largely involved in heredity and also in control of biochemical activities in cells. Those subjects are extremely fascinating at present and may be portentous for the future. However, in my opinion nothing that has so far been learned about DNA has helped significantly to understand the nature of man or of any other whole organism. It certainly is necessary for such understanding to examine what is inherited, how it is expressed in the developing individual, how it evolves in populations, and so on. Up to now the triumphs of DNA research have had virtually no effect on our understanding of those subjects. In due course molecular biology will undoubtedly become more firmly connected with the biology of whole organisms and with evolution, and then it will become of greater concern for those more interested in the nature of man than in the nature of molecules.

Finally, it should be pointed out that although man is a unique animal and although we properly consider his nature in the light of his peculiarities, he also has many non-peculiarities. Man is not *merely* an animal, that is, his essence is not simply in his shared animality. Nevertheless he *is* an animal and the nature of man includes and has arisen from the nature of all animals. Indeed if all the material characteristics of man could be enumerated, it would surely be found that the vast majority of them also occur in other animals. In fact at the level of molecular structure and interaction, information storage and transfer, energy transactions, and other defining characteristics of life, man is hardly significantly different from a bacterium—another illustration of the fact that that level of study is not particularly useful in considering the nature of man.

Like other animals, man develops, is born, grows, reproduces, and dies. Like other animals, he eats, digests, eliminates, respires, locomotes. He bends the qualities of nature to his own ends, but he is as fully subject to nature's laws as is any other animal and is no more capable of changing them. He lives in biological communities and has a niche and an ecology, just as do robins and earthworms. Let us not forget those aspects of man's nature. But let us also remember that man stands upright, builds and makes as never was built or wrought before, speaks and may speak truth or a lie, worships and may worship honestly or falsely, looks to the stars and into the mud, remembers his past and predicts his future, and writes (perhaps at too great length) about his own nature.

References and Notes

1. C. Darwin, *The Descent of Man, and Selection in Relation to Sex* (Murray, London, 1871).
2. ———, *On the Origin of Species by Means of Natural Selection, or The Preservation of Favoured Races in the Struggle for Life* (Murray, London, 1859).
3. T. H. Huxley, *Evidence as to Man's Place in Nature* (Williams and Norgate, London, 1863).
4. Lamarck's view (unknown to most Neo-Lamarckians) was that *all* organisms are evolving toward and will eventually become human, after which they will degenerate through the inorganic world and eventually be spontaneously generated as lowly organisms and start again on the path to man. Today's amoeba is tomorrow's man, day after tomorrow's mineral, and still another day's amoeba once more. In the state of knowledge and philosophy of Lamarck's day it would perhaps be too strong to label his views as absurd, but they were certainly less sensible and less progressive than has often been claimed.
5. These new data are well exemplified in S. L. Washburn, Ed., *Classification and Human Evolution* (Aldine, Chicago, 1963).
6. E. L. Simons and D. R. Pilbeam, *Folia Primatol.* No. 46 (1965).
7. On this and other absolute (year) dates see D. E. Savage, J. F. Evernden, G. H. Curtis, G. T. James, *Am. J. Sci.* **262**, 145 (1964).
8. E. L. Simons, *Postilla* (Yale Peabody Museum) No. 57 (1961); *Proc. Nat. Acad. Sci. U.S.* **51**, 528 (1964).
9. L. S. B. Leakey, P. V. Tobias, M. D. Leakey, J. R. Napier, *Nature* **202**, 3 (1964); P. V. Tobias, *Science* **149**, 22 (1965). For discussion and dissent see P. L. DeVore, Ed., *The Origin of Man* (transcript of a symposium, Wenner-Gren Foundation, New York, 1965).
10. Age-long argument on the definition of species is perhaps sufficiently summarized in G. G. Simpson, *Principles of Animal Taxonomy* (Columbia Univ. Press, New York, 1961) and E. Mayr, *Animal Species and Evolution* (Harvard Univ. Press, Cambridge, 1963).
11. On animal races see especially Mayr (*10*). On the perennial, knotty problem of human races, a sensible general statement with many references is in Th. Dobzhansky, *Mankind Evolving* (Yale Univ. Press, New Haven, 1962).
12. J. Goodall, in *Primate Behavior*, I. DeVore, Ed. (Holt, Rinehart and Winston, New York, 1965), p. 425.
13. The literature on human culture and linguistics is as voluminous as that of any field of science. Some recent studies especially pertinent to my text are: A. L. Bryan, *Current Anthropol.* **4**, 297 (1965); M. Critchley, in *Evolution after Darwin*, S. Tax, Ed. (Univ. of Chicago Press, Chicago, 1960), vol. 2, p. 289; A. S. Diamond, *The History and Origin of Language* (Philosophical Library, New York, 1959); E. L. DuBrul, *Evolution of the Speech Apparatus* (Thomas, Springfield, Ill., 1958); B. R. Fink, *Perspectives Biol. Med.* **7**, 85 (1963); C. F. Hockett, in *The Evolution of Man's Capacity for Culture*, J. N. Spuhler, Ed. (Wayne State Univ. Press, Detroit, 1959), p. 32; C. F. Hockett and R. Ascher, *Current Anthropol.* **5**, 135 (1964); A. Kortlandt, *ibid.* **6**, 320 (1965). See also works cited in *16*.
14. Misuses of the term "language" are too widely exemplified to need citation. The distinction is discussed by several of the authors cited in *13*, also (among other places) in J. B. S. Haldane and H. Spurway, *Insectes Sociaux* **1**, 247 (1954) and J. B. S. Haldane, *Sci. Progr.* No. 171, 385 (1955).
15. C. Darwin, *The Expression of the Emotions in Man and Animals* (Murray, London, 1872).
16. J. B. Lancaster, in *The Origin of Man*, P. L. DeVore, Ed. (transcript of a symposium, Wenner-Gren Foundation, New York, 1965). See also discussions by A. R. Diebold, Jr., T. A. Sebeok, D. Slobin in the same volume, and bibliography on pp. 149–150.
17. I first began to appreciate the richness and complexity of "primitive" languages when I visited the Kamarakotos of Venezuela in 1939, and I commented on it in G. G. Simpson, *Los Indios Kamarakotos* (Ministerio de Fomento, Caracas, 1940).
18. N. Geschwind, *Brain* **88**, 237 (1965).
19. G. G. Simpson, *Am. Psychologist* **21**, 27 (1966).

20. During 1965 varying versions of this essay were presented as lectures at Randolph Macon College, the University of Paris, and the University of Washington. I have profited by discussions on those occasions.