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THE EVOLUTION OF HUMAN BEHAVIOR

BY

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PREFACE

THE general topic of human evolution is exceedingly broad and hence can be approached from many diverse angles. Most of the books that have appeared in this field up to the present have dealt almost exclusively with the evolution of man's bodily structure. Quite aside from this limitation, many of them are too detailed and technical to be of much value to the general reader.

In the present volume, behavior rather than bodily structure has been stressed. The writer believes that the evolution of human intelligence, with its almost limitless capacity for cultural development, should be regarded as the central theme of the general problem. The facts of structural evolution must find their larger meaning in terms of the cultural evolution which they have made possible. The psychological approach, growing out of this conception, offers a new orientation in interpreting the biological and sociological factors involved. The present treatment is as non-technical as could well be without sacrificing something of scientific accuracy.

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C. J. W.

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THE EVOLUTION OF HUMAN BEHAVIOR

Chapter I

SOME PROBLEMS OF HUMAN EVOLUTION

The problem of human origins has long been a central one in the endeavor of mankind to understand the nature of the universe. No one can say just when our ancestral forbears, in the evolutionary sense, first turned to reflection and began to be curious as to how they came to exist as men. However, it must have been at some exceedingly remote epoch in the past—long before the dawn of the historical period. This is indicated by the fact that a general interest in this problem is reflected in the earliest mythology of which we have any account. The creation legend, with its usual naïve explanation of the origin of man, must be regarded as being among the oldest and most widespread fragments of primitive folklore. How early such myths were invented no one can tell. For, as they come to us, they are already hoary with age, and represent miscellaneous accretions from the untold millennia of earlier folk life.

The problem of human origins retained its position of dominance when man finally began to doubt the ancient myths and to observe the facts of life in the light of reason. The early Greek thinkers were among the first to cast aside the authority of the legend. Their speculations regarding the origin of man and his culture as a part of the natural order marked the first important beginnings of the scientific approach to the problem. As might have

been expected, some of the notions of these pioneer scientist-philosophers relative to the nature and origin of man were little better than the myths which they had rejected. However, as Osborn (6) has shown, certain theories growing out of this movement are strikingly similar in many respects to modern scientific conceptions. Whatever the value of their specific contributions, they performed an immense service to mankind by bringing the problem of human origins into the field of scientific thought. As Osborn has also shown, the attempts to account for man and his behavior along naturalistic lines from this time forward forms one of the most interesting chapters in the history of science.

No one can survey the long struggle toward modern conceptions of human origins without being strongly impressed by the stubborn reluctance of man to accept his rightful place in the natural order. The notion that the genus Homo is, after all, merely the most complex and perfect living organism that nature has so far been able to produce is at least as old as Aristotle. In spite of this fact the scientific point of view never became firmly established, even among the more intelligent, until comparatively recent times. The ancient heritage of myth and legend, duly ensconced in a theological setting, and the unreasoning natural arrogance of man himself have conspired to prevent the normal development of this conception during centuries of general intellectual progress. From the time of Darwin onward, however, a mass of irrefutable supporting evidence has been in process of accumulation from several more or less independent lines of approach. At the present time it is possible to define man's place in nature with greater accuracy and certainty than can be done in the case of most other existing types. In fact, the evidence showing man's genetic relationship to the higher animals has tended more and more to become

one of the strongest links in the general theory of evolution.

One of the chief difficulties in the way of coming to a proper understanding of the problem arises from the fact that man himself holds a favored place in the system of nature. By virtue of a general evolutionary advance he has come into possession of certain special endowments which now enable him to pass judgment upon his less favored relatives without let or hindrance. Among the ignorant and unthinking, this condition of affairs has led to the blind and futile prejudice which would make of man an altogether distinct creature set apart from the rest of living nature by a superhuman power. But even when an intelligent and sympathetic approach to the problem can be made, it is often not easy to take a wholly objective attitude. It is one thing, for example, to investigate the evolution of the insect or the horse, and quite another to examine into the facts regarding the evolution of man. The doctrine of the primacy of man, in the supernatural or theological sense, is so deeply rooted in our habitual modes of thought, that it is likely to persist after a long schooling in scientific objectivism.

This common bias accounts for the fact that a few professed evolutionists are willing to include mankind in the scheme only with certain more or less vague reservations. There are those, for example, who hold that while man's bodily equipment and powers are unquestionably derived from his animal ancestry, his mental and moral capacities must have come from some other source. Such a compromise position shows a most hopeless confusion as to the essential nature and conditions of the evolutionary process. In the first place, it creates a false distinction between the morphological, physiological, and behavioral aspects of the living organism which modern biology disavows. Structure and function, bodily powers and be-

havior, are not distinctive and separate evolutions but merely logically conceivable aspects of a single and unitary evolutionary process. Furthermore, the comparative psychologist finds no greater differences between the behavior of man and other animals than might be predicted on the basis of structural differences. Intelligent behavior, as we shall see, has played an important rôle in the evolutionary process all along the line, but this need not mean that intelligence should be regarded as something apart from other factors. The mental and moral life of mankind must certainly have arisen from biological and social conditions, but these must be thought of as operating together at the human level if we are to avoid the many false issues which are so often associated with this view.

In approaching the problem of human origins from a naturalistic and evolutionary viewpoint, the matter of a proper perspective becomes all-important. We must cast aside the notion that human evolution somehow involves new and diverse principles as contrasted with the evolution of living organisms in general. Naturally enough, the emergence of a living type of man's complexity supposes new specific factors and relationships. But the same principle applies in the evolution of any complex form from one of simpler type. The primary principles underlying the evolutionary process are the same at every stage—they are general and continuous. The concrete conditions, as expressive of these principles, may be as numerous and diverse as the intrinsic richness of animate and inanimate nature will allow. It is clear, therefore, that a genuine understanding of human evolution must be deeply grounded in the broader facts of organic evolution in general. In the several sections of the present chapter that follow, some of the more important of these facts and principles will be briefly discussed. The aim will

be to secure a sound perspective from which to examine the evidence regarding the evolution of man and his behavior.

What Evolution Means

We have been using the term evolution, up to the present, in the restricted sense in which it is applied to living or organic types. It is well not to forget, however, that organic evolution in its entirety is only a part of the larger process which includes the evolution of the physical world as well. The main facts regarding the latter phase of the process have been summarized in a recent volume (1) and need not be discussed here. Not until the earth had undergone an extremely long series of changes could a set of conditions arise favorable to the origin and continuance of living forms. Since that period began, the earth has continued to change in numerous ways influencing greatly the suitability of its outer crust as a habitat for the living types which have come into being. And, as we shall see, the main line of advance in the evolution of higher or complex forms is more or less closely associated with major changes in the earth's crust. In fact, the evolution of the earth and of its inhabitants comprises a single interrelated series of events, when viewed in broad perspective.

In general, the concept of evolution implies that selective change is a primary characteristic of both living and non-living things. It thus agrees with the dictum of common sense that the thing of to-day cannot be precisely the same as it was yesterday or as it will be to-morrow. At bottom evolution is a dynamic conception of nature in which processes and events are recognised as being fundamental to existence in the sense of persistent continuity. Identity is more or less bridged by the fact that the changes

occurring are relatively slow and cumulative; it is lost in so far as one thing eventually changes into another. If such a dynamic concept can be applied to nature in general, how much more correctly does it picture the facts regarding the continued existence of living nature! For, as everyone knows, the most characteristic property of living substance is its almost limitless capacity to make adaptive adjustments to an ever-changing environment. The living organism is the natural system *par excellence* for making the very kind of selective change which the theory of evolution requires. Once living substance appeared upon the scene, it would be strange indeed if organic evolution as we know it had not occurred.

No one questions the fact of change in the individual organism during its natural life span. The basic vital activities, associated with metabolism, growth, and reproduction make up the daily round of life in the case of many simple types. In any event, the bare process of living may be regarded as continuous adjustments within the organism and between the organism and its environment, as Spencer so aptly suggested. In a sense there is no such thing as life but only living organisms, the term life being merely a logical abstraction from living processes in general. The individual organism and its environment are so intimately interrelated that, except for the sake of brevity, we ought always to speak not of the organism but of the organism-in-environment. The living processes of the organism, to follow the analysis of Osborn (5), are largely or wholly concerned in the capture of energy from the environment, the storage of this energy, the transformation of the stored or latent energy into potential energy, and the harmonious release of the energy in vital activities and behavior. Since the individual organism is so closely linked up to environmental forces, and must continually adjust itself to external changes during its

life span, why should it be supposed that the type itself would remain unchanged over long periods of time? In brief, the facts of development suggest, at least, the possibility of an evolution.

The evolutionist, beginning with this possibility, finds multitudinous facts to support it. He has come to insist that the species or type, like the individual, is not fixed and immutable, but is continuously changing in response to environmental forces. The changes which occur in the type, when long periods of time are taken into account, are often so important as to give rise to a new species or variety from the old. On looking further, he finds that the type also passes through a more or less regular cycle of development which he terms evolution. The concept of the type takes on a dynamic aspect, therefore, and becomes merely another instance of the organism-in-environment relationship. Some types appear to change more readily than others, or perhaps are subjected to more change-producing conditions than are their contemporaries. The environment is sometimes relatively stable for comparatively long periods, and at other times is characterised by sudden changes and swift upheavals. As a result, we find nature continually creating new types, preserving old types with minor modifications, or doing both simultaneously under divergent conditions.

Individual change, or development, and type change, or evolution, are similar in that both arise from a common matrix—the organism-in-environment relationship. As concrete natural processes, however, they differ in several important respects. The life cycle of the individual is short—rarely is it longer than a century—and the influence of the environment is direct and immediate. The cycle of the type is incomparably longer and the significant environmental effects are indirect, as will be explained in the following section. This implies that the mechanism

of adjustment is essentially different in development and in evolution. In the one case it is primarily somatic or bodily, and in the other wholly germinal. However, both are rooted in the common property of living protoplasm to change in response to internal and external conditions. The series of changes which, when taken together, comprise the developmental pattern of the individual are easily observable, while the changes underlying the evolution of types, including mankind, become apparent only after they are brought to light by diligent search. Doubtless this in part accounts for the fact that the dynamics of the organism was earlier recognised in the field of development than in the field of evolution.

How New Types Originate

As we have suggested, the processes underlying the evolution of types or species are indirect and relatively slow. The primary reason for this grows out of the fact that the type changes, upon which evolution is based, must originate in the germ plasm. This is true, at any rate, of organisms high enough in the scale to reproduce themselves by sexual methods. In such organisms, the germ plasm is segregated in some definite part of the body of the individual, where it is more or less protected from direct internal and external influences. This protection is not absolute, since unusual or very severe bodily or environmental changes may affect it, but the changes so produced have little or no evolutionary significance. The germ plasm carries the genes, which are known to be the active agents in heredity, determining in large measure the basic constitution of the offspring. The segregation of the germ plasm may be considered as a device evolved by nature to shield the germinal elements from the direct and immediate forces of the environment which continu-

ally influence the soma or body. This makes for the preservation of the type and thus limits the speed of the evolutionary process, which must depend upon the indirect selective influence of the environment.

Such, at any rate, is the generally accepted view of the matter in modern biological circles. The earlier evolutionists, including Lamarck and Darwin, supposed that somatic changes in the individual might be in some manner transferred to the segregated germ plasm and thus be transmitted to progeny. The inheritance of acquired characters, as this older view is called, was stressed especially by Lamarck. It is still held to-day by a few neo-Lamarckians but has been cast aside as highly improbable by most modern biologists. The chief difficulty in applying it grows out of the inability to conceive of a mechanism whereby somatic changes might be transferred to the segregated germ plasm. The germ cells do not develop even the rudiments of the normal bodily parts while thus segregated in the parent body. Darwin himself made little use of the principle, depending more largely upon the agency of natural selection. An excellent and impartial review of the evidence both for and against the Lamarckian hypothesis will be found in a recent volume by Kellogg (3). Since modern geneticists, in general, reject the notion of acquired somatic changes, the origin of species must be accounted for in terms of germinal changes and natural selection.

The evolution of the full-fledged new type can be thought of as involving two processes or stages. The first stage is sometimes spoken of as the primary, or species-forming process, and is dependent upon the appearance of germinal variations of some sort. It is well known that the germ plasm, segregated within a given individual, possesses a natural tendency to vary within certain limits. This is shown by the fact that the progeny of the same

individual or parents differ in many particulars, as may be easily observed. In many cases, at least, these variations within the same family are clearly traceable to hereditary or germinal factors. It is not necessary to suppose that every germinal variation possesses evolutionary possibilities, for in some instances they are slight and relatively superficial. The essential thing is that certain germinal variations should arise from time to time which are significant enough to become the starting points of new species or varieties. That this actually happens can not be doubted. It is thus clear that the mechanism of heredity, which on the whole makes for the preservation of the type, also on occasion supplies the germinal variations which mark the beginnings of a new type from the old.

As a rule, biologists recognise two kinds of germinal variations from which the first stage of evolution, or species-forming, might take its rise. The most common kind comprises the germinal variations which occur in the ordinary course of the hereditary diversification of offspring, as noted above. The germinal materials segregated in the parent body must pass through a process of maturation, or ripening, before they are ready to be utilized in fertilisation. One important function of this maturation process is the separation of the genes of the strain from each other and their later recombination in the mature sperm cells and ova. These recombinations occur according to chance, and this would mean that the specific germ cells that may be later fertilised and develop into offspring differ among themselves as to hereditary character. This explains the fact of variation in the progeny of the same parents, since each individual develops from a single fertilised germ cell possessing only one of the possible gene recombinations of the parental strains.

In bi-parental organisms the possibility of germinal variation is considerably increased by the mixture of

strains, differing somewhat in gene constitution, from generation to generation. If we suppose that a recombination of hereditary units, arising from strain hybridization, or cross-breeding, is occasionally different enough to represent a start toward a new type, then we have a natural basis for evolutionary change in the normal heredity and reproductive mechanisms of higher organisms. Mutations comprise a second and much less common kind of germinal variation which does not depend upon gene recombinations. No simple explanation of the causes underlying the appearance of mutations can be given, and the reader is referred to some standard text on genetics, such as Conklin (2), or Newman (4), if he wishes to follow up this point.

Most biologists recognise the possibility that both types of germinal variation may serve as the beginnings of a new species or variety. Opinions differ, however, as to the probable relative importance of the two in organic evolution. The field biologists, who observe the results of evolution most directly, tend to stress the significance of recombinations in natural speciation. Geneticists of the laboratory type, on the other hand, emphasize the importance of the mutant, which so far as known is largely a laboratory product. The mutationists point out the difficulty of bringing about a divergence important enough to mark the beginning of a new species by the mechanism of recombinations. They argue that all recombinations must lie within the range of the old species and hence could hardly give rise to a new type. However, such arguments fail to take into account the complexity of the mechanism of recombination, operating under the usual conditions of hybridization in nature. Nor is there any reason to suppose that the range of variation for a given character in a species is fixed within such definite limits as to make impossible the appearance of marked divergences

capable of setting up a new trend. The mutant, on the other hand, has the advantage of representing a more discrete and divergent individual from the start, although, as often pointed out, it usually involves losses rather than gains in germinal constitution. This does not prove, of course, that mutants representing gains in germinal factors will not sometime be produced experimentally, nor that such do not actually now arise in nature. On the whole, it does not much matter whether the first stage of the evolution of the type is based upon recombinations or mutations, since either appears to offer the needed germinal basis which the evolutionary theory requires.

The germinal variations, however they may arise, must be aided by other factors if they are to result in full-fledged new varieties or species. As a rule, individuals representing differences due either to recombinations or to mutations breed freely with the parental and related strains. Naturally, promiscuous inter-breeding would tend to swamp out the new germinal variation and prevent it from being preserved in a discrete strain. In process of time a new variety or species comes to be infertile with the parent and related stocks, but this appears to be seldom if ever true when new variations make their first appearance. Such protection of the variation as is necessary may be afforded by geographical isolation of the incipient species, of such a sort as to prevent interbreeding with the parent and related stocks. Much the same result would be secured by biologic or physiological isolation provided the breeding season of the new type came either earlier or later than that of the old or related stocks. Some one of the several types of reproductive isolation might also be effective. For example, assortative mating based upon antipathy toward dissimilarities in color, odor, or the like, or the mere mechanical lack of fit in the sex organs might suffice. Any condition whatsoever which will lead

to greater fertility within the variant group than with groups not possessing the new character will bring about a progressive tendency toward greater divergence. In process of time the divergence may thus become great enough to lead to practical sterility in so far as the old or related stocks are concerned. When this point is reached, a new type or species has been evolved.

Trends in Evolution

The notion of a cumulative tendency, or trend is implicit in the general concept of evolution. If evolution meant no more than mere change, then there could be no such thing as true genetic relationships among plant or animal types. As a matter of fact, nothing is more apparent in dealing with evolutionary materials than the presence of trends of one sort or another. Each new type that evolves must either mark the beginning of a new trend or take its place as a link in the continuance of a trend already established. When large sections of the living world, such as phyla, are examined certain trends running throughout are inevitably discovered. It is doubtless also true that a few more or less definite general trends characterise the process of organic evolution as a whole. It is the widespread occurrence of trends which enables the biologist to bring the whole of living nature, both past and present, into a single genetic unity with varying degrees of kinship. Illustrations of certain trends relating particularly to the evolution of man will be found in the following chapter. Our present interest is to inquire into the natural causes which underlie evolutionary trends in general.

The most common and basic trend in organic evolution is that involved in the origin of a full-fledged new type. As we have seen, the primary rôle in the initial episode of

the origin of a new variety or species is played by a specific germinal variation, either of the recombination or mutant sort. Special conditions, often involving a long period of time, are usually necessary, however, in order to set up a progressive tendency in the variant character until the character, or complex of characters, becomes fixed in the type. The simplest explanation of the continuance of the character trend during the establishment of the type as a species non-fertile with other species is some form of selective mating. Most biologists believe that germinal variations—whether arising from recombinations or mutations—must be protected during this early period by geographical, physiological, reproductive, or some other kind of isolation. This means that while the primary factor in the origin of a new type is germinal, the evolution of the full-fledged type requires the aid of bodily or environmental factors. The basic trend toward the distinctive and fully formed new type is thus made to depend upon other than germinal factors. This view is clearly in harmony with the principle that evolution is essentially an organism-in-environment process.

A few biologists seem reluctant to admit the point that environment thus plays the dominant rôle in determining the basic trend in the evolution of the full-fledged type. This group makes appeal to the doctrine of orthogenesis which, in one form or another, supposes that the germinal variations arise according to some sort of intrinsic plan which foreshadows the perfected type. An excellent discussion of the several theories of orthogenesis will be found in a recent volume by Kellogg (3), and need not be treated here in detail. The facts seem to be that both kinds of germinal variations show a chance order and not a progressive series as orthogenesis would require. It has long been known, for example, that chance operates in the recombination of the hereditary units during matura-

tion, so that no trend toward progressive variation in a given character occurs. A similar lack of definite order is also the rule in the variations which appear in a mutating stock. It is clear, then, that there can be no germinal basis for trends in so far as the initial stage of species-forming is concerned. Variations make their appearance at random within the limitations set by the natural constitution of the germ plasm. In the long run, the trend comes down to a germinal characteristic, but this is brought about by the selective forces of the environment in the elimination of non-conforming individuals and their progeny.

The agency of the environment in the setting up of the trend toward the full-fledged type, as well as other and broader trends in evolution, is termed natural selection. In order to be effective in the indirect or germinal sense, the complex of environmental forces must eliminate the non-conforming individual before it comes to maturity and leaves progeny. In so far as the eliminative process tends to weed out in this manner individuals whose hereditary make-up differs from that of the dominant strain, it sets up a progressive trend favorable to the continued evolution of the type along the line of specific variation. While the direct effect of natural selection is thus to eliminate the non-conforming individuals as such, the indirect effect which involves selective reduction of germinal potentialities along certain lines is the important aspect for evolution. Numerous environmental factors enter into the determination of the trend toward a specific full-fledged type, and of other and broader trends which have been observed. We have already mentioned the selective effects of geographical and other kinds of isolation. Important environmental changes such as those involving the food supply or climate might easily favor one type of variant over another and thus prove selective. The mi-

gration of animals, already adapted to one life zone, into another of a markedly different sort would also be likely to set up new trends. As a rule, the germinal evolution induced by natural selection requires a long period of time in order to be brought to completion.

The manner in which environmental factors operate in bringing about trends in a given stock is well illustrated by the results of the adaptive radiation of the mammals into divergent life zones. The analysis of Osborn (5) is shown in the accompanying diagram. As will be seen, the common ancestral mammal was a small arboreal type possessing more or less generalised bodily mechanisms. As the progeny of this ancestral type invaded other possible habitat zones from time to time, trends toward diverse kinds of specialisation made their appearance. The organs of feeding and of locomotion in particular show marked adaptations that may be directly related to the new conditions of existence in the several life zones. The rate of change in specialisation varies from organ to organ under such conditions, and the order of change also varies among different types. Naturally these adaptations did not arise at once, but the trends set up by the shift to a new environment continued until the diversified mammalian class as we know it to-day had been evolved. Many of the intermediate stages are represented by fossil types discovered by the paleontologist. The law of adaptive radiation, as here exemplified in mammalian evolution, may be regarded as a general principle applying to all other large groups of animals.

Values in Evolution

No question has given rise to more vexatious controversy than that regarding the system of values implied in the theory of organic evolution. The chief difficulty

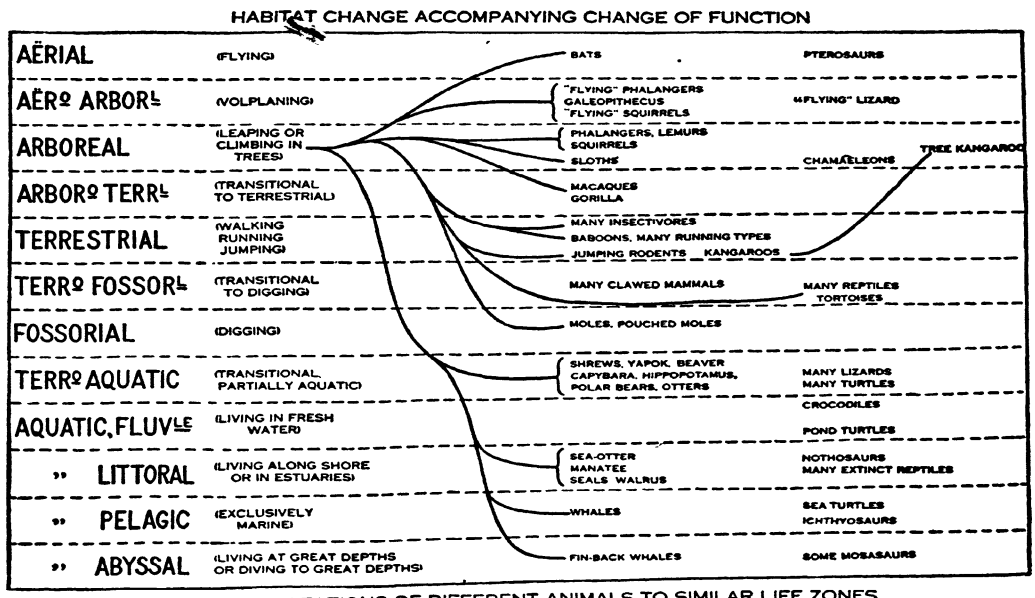


FIGURE 1. ADAPTIVE RADIATION OF THE MAMMALS

The mammals, probably originating in arboreal leaping or climbing phases, radiate adaptively into all the other habitat zones and thus acquire many types of body form and of locomotion more or less convergent and analogous to those previously evolved among the reptiles (shown in the right-hand column), the amphibians, and the fishes. Diagram by Osborn and Gregory. (From Osborn, H. F., "The Origin and Evolution of Life." Charles Scribner's Sons.)

grows out of our inability to distinguish clearly and definitely between biological and strictly human values. When this can be done, it becomes evident at once that the ability to survive must constitute the primary value in the scheme of evolution. In order that life itself survive, nature has decreed that types and groups of types that do not adjust to the changing environment must go. Likewise, the type must be preserved at the expense of the individual. Broadly speaking, this means no more than that open competition exists in nature and that the law of cause and effect operates rigorously. Competition in human society often means a disregard of the individual or the group, so that it may be doubted whether or not man has improved upon the plan of universal nature.

The general effect of natural selection is to produce types and series of types that are more or less well adapted to the conditions of life existing at the time. When the open competition of nature is decidedly keen, we say that the selective process is rigorous. Such a condition favors rapid evolution along a given line by furthering the progressive trend then under way. Nevertheless, rigorous selection does not seem to be favorable to survival, in the long run, unless the environment remains constant. Many instances might be cited indicating the fact that trends are likely to be carried too far. The price of perfect adaptation to one set of environmental conditions may be the inability to adapt adequately to another. This explains how natural selection often produces and afterwards destroys a given type. The long-horned Irish stag of recent times, and the minions of older extinct forms, illustrate how the favored of to-day may become the victims of to-morrow. The same penalty is exacted for over-adaptation as for under-adaptation, as a rule, and only those types survive for long which somehow follow a middle course. The exceptions appear to be among simple organ-

isms living in a relatively stable environment. It is evident, therefore, that the mere presence of trends in evolutionary material does not necessarily argue for biological value. Whether or not an adaptive trend may be considered valuable depends entirely upon the final outcome in the game of life.

The importance of balance in degree of adaptation to environment is well illustrated by the progressive trend toward complexity of type as we ascend the phyletic scale. As is well known, the advance steps in this direction have been taken, as a rule, by more or less generalised forms which had not as yet developed structural adaptations to a particular environmental complex. The amphibians, for example, arose from a relatively simple fish ancestor, the reptiles from a like amphibian ancestor, and the birds and mammals from a generalised reptilian form. This fact is illustrated in a schematic way in the diagram of Figure 2. The main line of evolutionary advance has seemed to depend all along upon balanced types in the sense here indicated. A high degree of structural adaptiveness appears to carry with it the penalty of the loss of potential specialisation in other directions, and especially so if the specific modification has been carried far. This is true because of the indirect germinal selective action involved in the evolution of adaptive structures. For example, the once tridactyl foot of the horse is forever lost to the species because of the specialised monodactylism that later evolved. In this sense, structural evolution is irreversible in accordance with Dollo's general principle. In view of these facts, it does not appear that adaptiveness, in the structural sense at least, is an unmixed good—it may or may not possess biological value, depending upon the ultimate consequences.

As we have seen, trends and adaptiveness do not in themselves imply biological value, since either may easily

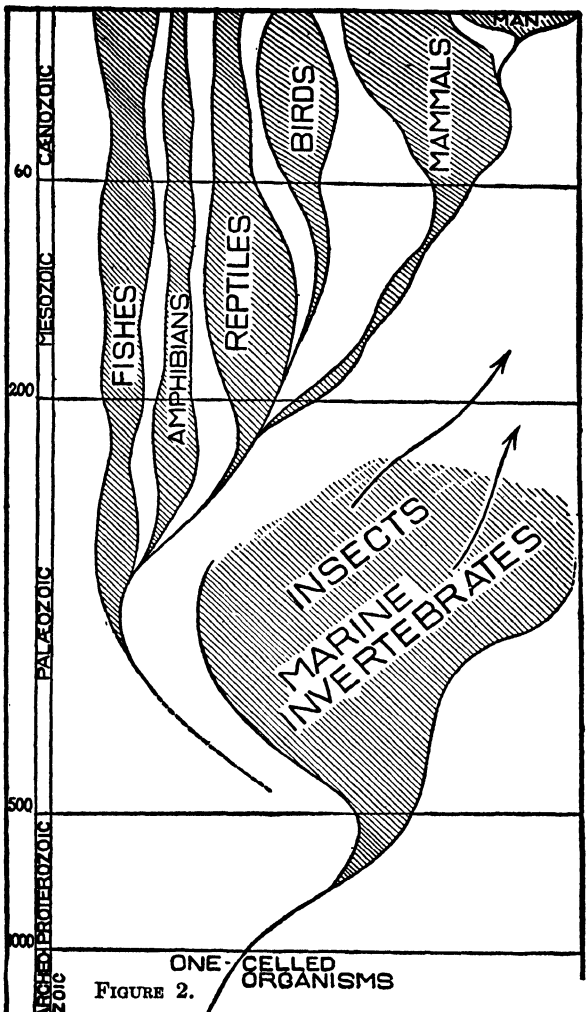


FIGURE 2.

GENEALOGICAL TREE OF ANIMAL LIFE

Figures at left give Barrell's time estimates in millions of years from beginning of each epoch to present, based on rate of disintegration of radioactive ores since they were crystallized at different geological ages. (From Gregory, W. K., "Our Face from Fish to Man." G. P. Putnam's Sons, 1929.)

be carried far enough to lead to the extinction of the type, or group. The question is pertinent, then, as to whether the evolutionary process offers any certain basis of value, aside from the bare fact of survival at any price. Perhaps, at least a secondary value may be found in the general trend toward complexity of type as we ascend the phyletic scale. If not here, then certainly nowhere else. We have already noted the fact that the evolutionary advance at every point depends upon the appearance of a new and generalised type of greater complexity. These pivotal ancestral types mark the general advance in level of organisation as we ascend the phyletic scale. This advance in level or organisation does seem, on the whole, to carry with it biologically significant possibilities, provided a proper balance is kept which will insure survival. The values which appear to grow out of a high level of organisation show themselves in a greater freedom from the direct dominance of the environment, and in a greater ability to manipulate and control external conditions. Complex organisation appears to imply values of a secondary sort, also, in so far as it makes for the enrichment of sensory contacts with the environment and for diversity and complexity of behavioral adjustment.

The claim is sometimes made that the central value in evolution is the trend toward the human type of intelligence. Such a notion may be criticised on several grounds. In the first place the comparative psychologist (7) finds little or no evidence for such a trend when the whole range of living organisms is taken into account. The behavior of any given type is a function of the general level of organisation and of the sensory, neural, and reactive specialisations represented. In so far as intelligence can be identified with behavior potentialities, it must also be dependent upon these same factors. It follows, therefore, that intelligence no more than structure and function in general,

can be thought of as falling into a linear series leading directly to man. If intelligence be identified with adaptiveness, then, as we have noted, its biological value becomes open to question. Furthermore, many simple, non-progressive types, which are usually rated low in intelligence are well adapted to their environment, as shown by long survival of changes that have swept numberless complex types away. However intelligence may be defined, any implications of value therein derive from the natural association of high intelligence with a high level of structural and functional organisation. Whether or not the human kind of organisation and intelligence is a pivotal and balanced type, forming a link in the progressive trend to further evolution, or a one-sided, specialised type doomed to ultimate extinction can in no wise be predicted in advance.

Missing Links and "Living Fossils"

In order to secure a genuine insight into the evolution of the human or other modern type, it is necessary to trace genetic relationships backward through long periods of time. It is important to be able to distinguish recent from more remote acquisitions, and thus to place the evolutionary account in its proper temporal setting. This is especially desirable in the case of such relatively late arrivals on the scene as man and his close of kin. When we consider the vast numbers of extinct and living types that must bear some genetic relationship to the human stock, the task of discovering the broad outlines of human evolution seems almost hopeless. The problem is very much simplified, however, by the fact that the main line of descent leads through pivotal generalised types which mark the basic advance toward higher levels of organisation. This enables us to ignore the multitudinous collateral types which, while sharing in the evolutionary advance, have

made no contribution to the direct ancestral line leading to man. After decades of patient and coöperative endeavor, the paleontologist and comparative morphologist have been able to determine for us the main stages in the human ancestral line. The relevant facts will be presented in the following chapter. For the present we wish to discuss briefly the nature of some of the more important sources of evolutionary material.

The fossil record supplies the primary source of evolutionary fact. The paleontologist is continually searching the strata of the earth's crust for such fossil remains as will enable him to bring into a single unity the past and present organic world. His finds consist largely of shells, bones, teeth, and other hard parts of animals—since these are the remains most readily preserved in the water-borne sediments of the stream or in the wind-borne loess of the plains. These discovered parts must be reconstructed by the comparative morphologist and assigned to their proper place in the indicated line of descent. The most eager search of the paleontologist is, naturally, for the pivotal types which, as we have seen, mark the general advance toward complexity of organisation. Even when a fossil discovery turns out not to be one of these important missing links, it often happens that it is a closely allied contemporary type of great significance to the evolutionist. Contrary to popular opinion, the missing link most sought for by the paleonotologist from time to time is not the so-called "missing link" between man and the anthropoid apes. Such relatively recent records are already fairly complete; the real missing links relate to the more remote stages of evolution which cannot as yet be certainly deciphered. When the difficulties of fossil preservation and the chance element in discovery are taken into account, the fact that there are still a few important missing links to be found is certainly not astonishing.

Eras	Major Divisions	Periods or Epochs	Evolutionary Advance
Cenozoic (55)	Quaternary or Age of man	Recent (0.03)	Bronze and iron ages; world civilisations Mesolithic and neolithic cultures
		Pleistocene (0.97)	Extinction of the great mammals Periodic glaciation: paleolithic man
	Tertiary or Age of mammals	Pliocene (6)	Primitive man: eolithic or dawn man Evolution of humanoid types
		Miocene (12)	Great apes: orang, chimpanzee, gorilla Divergence of pro-ape and pro-man stems
		Oligocene (16)	Evolution of great anthropoid stem Monkeys and gibbon-like primates
		Eocene (20)	Lower primates: lemuroids and tarsoids Archaic mammals; rise of modern mammals
Mesozoic (135)	Secondary or Age of reptiles	Cretaceous (65)	Extinction of the great reptiles Rise of placental mammals: insectivora
		Jurassic (35)	Rise of marsupial mammals Rise of flying reptiles and birds
		Triassic (35)	Cynodonts and egg-laying mammals Rise of great reptiles: dinosaurs, etc.

Paleozoic (360)	Upper Paleozoic or Age of fishes and amphibia	Permian (25)	Periodic glaciation: mammal-like reptiles Rise of modern insects
		Carboniferous (85)	Aridity: rise of primitive reptiles Rise of echinoderms and insects
		Devonian (50)	Semi-aridity: rise of amphibians Lobe-finned ganoids of the swamps
	Lower Paleozoic or Age of higher invertebrates	Silurian (40)	Sharks, ganoids and lung-fishes Rise of primitive fishes
		Ordovician (90)	Armored fishes, or ostracoderms Rise of corals and land plants
		Cambrian (70)	Trilobites and molluscan nautilids Rise of shelled animals
Proterozoic (450)	Age of lower invertebrates	Pre-Cambrian (450)	Trials and burrows of segmented worms Rise of primitive metazoan types Limestone formations: secretions of algae
Archeozoic (500)		Archean (500)	Simple unicellular plants and animals Beds of graphite, probably organic Origin of primitive living systems
Total time (1500)		Igneous rocks	The evolution of the earth

FIGURE 3. GEOLOGIC TIME TABLE

The figures in parentheses indicate the estimated duration of the several eras and epochs in millions of years based upon the rate of disintegration of the radioactive ores. The estimates for the five great eras based upon the thickness of the sedimentary rocks are as follows: Cenozoic, 3; Mesozoic, 32; Paleozoic, 25; Proterozoic, 16; and Archeozoic, 25; making a total of 100 million years.

In order to place the facts of evolution in their proper temporal perspective it is necessary that fossil remains be properly dated. Modern paleontology has adopted the stratigraphic method in which the order of events is based upon the stratification of the earth's crust. The paleontologist determines the relative age of fossil remains by defining the geological strata in which they are found imbedded. The main geological eras and epochs, together with the general plan of the evolutionary succession of animal life, are given in the diagram on pages 24–25. The absolute time scale for the various geological epochs can be estimated only approximately at present. One method of estimation is based upon the average thickness of the successive geological strata, but this is not regarded as being very accurate since the general conditions of sedimentation at each level are not known and the rate in each case can only be roughly estimated. The more recently adopted method depends upon the amount of helium or lead which has accumulated in the strata, resulting from the breaking down of the radioactive substance, uranium. The rate of alteration under ordinary conditions can be accurately determined. As may be seen from the diagram, the latter method yields much higher absolute time estimates than the older method, and these appear, on the whole, to be supported by other lines of evidence. Doubtless many of the controversies among biologists regarding special points in evolutionary theory have been due to the general lack of understanding as to the immense temporal span involved in the process.

The term "living fossils" has been very aptly applied to the living representatives of the pivotal types which marked the emergence of a new level of complexity, or to some close relative of these. The survival of forms which show the early stages of new trends in the evolution of structure, enables the comparative morphologist to under-

stand in greater detail the fossil types to which it is closely akin. For, after all, the fossil consists of mere parts of the skeleton as a rule. The "living fossil" supplies in some measure the background necessary to the reconstruction of discovered pivotal fossils. Of special importance in this connection is the fact that complete life cycle studies can be made on the "living fossil." In general, the "living fossil" represents the survival of a stage of type-evolution which had not as yet been carried far. The fixation of types, after the rudimentary beginnings of a new character has made its appearance is, of course, a commonplace in evolutionary biology. The pivotal fossils and their living allies, the "living fossils," together comprise the basic materials from which to construct the main trunk and larger branches of the tree of life.

Evidences of Genetic Kinship

In the previous section we have called attention to the main sources of evolutionary material in the fossil and living world. If true genetic kinships are to be established, however, it is necessary for this material to be compared and arranged in the light of fundamental guiding principles. Although these principles appear to be simple when stated in general terms, the mature judgment arising from long years of training and experience is demanded in their concrete application. In many cases, a given kinship can be easily established because of the convergence of several more or less indipendent lines of evidence. In other cases, the matter is less simple because of the apparently contradictory nature of the evidence from different sources. In still other cases, there is a lack of sufficient data of any sort. Before discussing the genetic kinships which link the human stock to other organisms, we must consider briefly the general lines of evidence which

serve to guide the evolutionist in his task. The aim will be to bring into the foreground the fundamental principles underlying the several lines of evidence. All such principles rest ultimately upon the assumption that certain kinds of similarity among divergent types imply genetic kinship.

Perhaps the most fundamental guide to the evolutionist is the principle of homology as derived from comparative morphology, which includes the sub-sciences of anatomy and embryology. This principle is somewhat difficult to define clearly but can be easily illustrated. The arms of man are regarded as being homologous with the front paired fins of certain fishes, the wings of the bird, and the fore legs of the mammal, because of the fact that they all arise, in individual development, from similar embryonic rudiments of bone, nerve, and muscle. This fact constitutes so much evidence favorable to the view that all these types have evolved from a common ancestor in which these several specialisations had not yet occurred. The various differences in detail were later brought about by the adaptive radiation of the progeny of this common vertebrate ancestor into divergent life zones requiring the several specialisations. That such diversification of homologous structures may involve a change in the function or use of the part is obvious, since man, for example, no longer uses the arm as an organ of locomotion. The principle of homology rests ultimately upon the well-established fact that the individual during early development passes through certain phases which represent important stages in the evolution of the type. Modern biologists no longer accept the dictum that ontogeny repeats phylogeny in any elaborate or complete manner. Nevertheless, it is true that the main stages of past evolution are usually reflected in embryonic development. The large body of facts regarding homologous structures offers a broad and sound basis for the establishment of genetic kinships.

Another and related line of evidence indicative of genetic kinships is based upon the wide occurrence of vestigial organs in related forms. As a rule, vestigial organs are structures of relatively minor importance which are carried over to the new type, even though they are more or less functionless and useless under the new system of bodily organisation. In certain instances merely a decrease in function is shown, although this may often be considered as an early stage in the development of true vestigial organs. The vestigial status of a functionless structure is usually established by an appeal to the principle of homology. Vestigial wings are found in insects and birds, vestigial eyes in certain cave-dwelling fishes, vestigial toes on the leg of the horse, and a vestigial pelvic girdle and hind limbs in the abdomen of the blubber whale. The claim has been made by Wiedersheim that there are no less than 180 vestigial structures in the human body, so that man may be thought of as a veritable walking museum of antiquities. Attention will be called to some of these vestiges in the following chapter. Vestigial and related structures may be regarded as the driftwood of the evolutionary stream. They are evidences of the stubbornness with which structures once evolved resist the process of selective elimination. That they offer significant indications of genetic relationships in many instances cannot be doubted.

A third and wholly independent line of evidence is based upon the degree of similarity of blood composition among different types of organism. Nothing seems more reasonable than to suppose that the chemical constitution of the blood would change along with other aspects of the evolving organism. Some two decades ago, Nuttal showed this to be true by means of the precipitin reaction test. He found that a certain blood property might or might not be carried over to the several divergent types of a common

ancestor. The test makes use of the well-established principle in serology that the blood of an animal tends to become charged with a specific anti-body toward the injected serum of a sufficiently distinct type. The serum so charged, when dropped into a test tube containing blood of the injected, or a closely related variety, causes the formation of a whitish precipitate. The degree of relationship between the blood of various species and that of the injected variety is shown by the amount of precipitate formed and the readiness or speed of the reaction. More recently, another serological test, devised by Landsteiner and Miller, makes use of the reaction of the red blood corpuscles to the agglutinins. This is a much more delicate test of blood affinity than even the precipitin reaction, and the results so far obtained in the comparison between man and other primates will be discussed in the following chapter.

The precipitin test has been extensively applied to many of the larger groups of organisms. In general, the genetic relationships indicated by this test show a striking agreement with the system of relationships previously worked out on the basis of comparative morphology. For example, the primates show a closer affinity among themselves than that shown by any of this group to other mammals. It is interesting to note also, that the birds as a class appear to be much more closely related among themselves than are the mammalian types. This might perhaps be predicted because of the larger number of life zones invaded by the mammals than by the birds, when the adaptive radiation of these groups occurred. Birds also show a close affinity to the reptiles which agrees with the evidence from other sources in indicating the reptiles as ancestral to the birds. The blood test methods are of special importance since they constitute an independent check on the conclusions of comparative morphology.

They represent an important accessory to the general methods of comparative morphology which comprise the chief interpretative instruments in determining genetic kinships.

Up to the present time, comparative psychology has been able to contribute very little to the general problem of determining genetic kinships. This can be explained in part by the emphasis that has been placed by the evolutionist upon the structural aspect of the process. It may also be partly occasioned by the fact that the comparative psychologist has been, and continues to be, mainly interested in the behavior of existing types. It should be clear, however, that the behavioral side of the evolutionary process is most important and in due time must be given the attention that it naturally merits. Even at the present stage of the development of the science, there is reason to believe that the methods of comparative psychology can be made to yield information of genuine importance to the general problem of evolution. In the present treatment, we shall aim to include evidence from this source whenever possible.

Chapter II

THE NATURAL KINSHIP OF MAN AND ANIMAL

We now turn to an examination of the concrete evidence relating to man's place in nature in the light of the broad biological principles set forth in the previous chapter. In doing this we shall be obliged to content ourselves with a survey of the more outstanding facts and interpretations connected with the problem. The reasons which make such a simplification of the evidence necessary should be fairly obvious. In the first place, the sources of evolutionary material that might properly be drawn upon are exceedingly extensive. As one of the more complex and recent types, the genus Homo is connected with past and present living forms by an infinitude of diverse genetic bonds. Any worthy attempt to trace out these intricate relationships in detail would most certainly require a number of volumes. It is barely possible, within the limits of a single chapter, to offer a brief treatment of the pivotal fossil types, and their living allies, which lead more or less directly to the human stem. On this account, such interesting and corroborative evidence as might be drawn from the evolution of collateral stems must be largely eliminated from the present discussion. A number of books dealing with the materials of evolution in their more general connections will be found listed in the bibliography.

A somewhat similar limitation is necessary also with reference to the interpretative aspect of the problem. As we have stated previously, the general principles of interpretation underlying comparative morphology are simple enough, but the application of these to concrete details is a difficult and highly technical task. It would be worse than futile to attempt to bring into the present discussion the wealth of intricate detail upon which many of the conclusions of the evolutionist ultimately depend. The simple fact is that while such details are of immense value to the trained scientist in the analysis of evolutionary materials, their significance cannot be fully appreciated in many cases without a very considerable technical background. In the long run, the layman must bring himself to accept the conclusions of the expert evolutionist in the same way that he accepts the opinion of expert authority in other scientific fields. In the present brief treatment, we can seldom do more than present the better established conclusions of the expert on outstanding points. Nevertheless, this will provide us with a general outline of the evolutionary trend toward the genus Homo, with the proper emphasis upon the more important stages involved. Our central aim will be to assemble the facts regarding the pivotal types, and their "living fossil" allies, which represent the progressive stages of this major trend, and to place these facts in their generally accepted interpretative setting.

Naturally the more immediate genetic kinships are of most importance in determining man's specific place in the order of nature. In general, the kinships of most interest to us are those growing out of man's relationships to the vertebrate stem. The full vertebrate status was reached at a relatively recent period when the whole span of evolutionary time is taken into account. The main facts relating to the long ages of evolution prior to the coming of

the ancestral vertebrate type have been brought together under one section and termed remote kinships. The arrival of the vertebrate type upon the scene brings us face to face with the beginnings of the basic structural characteristics which man shares in common with other members of this great and advanced group. From this stage forward the evidences of kinship become increasingly numerous, definite, and cumulative as we approach the origins of the specific human stem. For this reason, the later sections, dealing with the more immediate relationships between man and animal, will be found more extensive and detailed. In following the general course of evolutionary events the reader should keep the diagram of Figure 3 continually before him so as to insure the proper temporal perspective.

Before passing to the main discussion, perhaps something should be said concerning the prior problem of the origin of the first living systems in nature. A general naturalistic conception of evolution takes for granted the emergence of primitive living creatures from non-living systems, either as a continuing process or as an event limited to some favorable past epoch. Positive evidence as to the nature of the first living forms and the physicochemical transformations underlying their emergence is almost wholly lacking. This is hardly surprising in view of the necessary simplicity of these earlier creatures. As Schäfer has pointed out, they probably consisted of a watery colloidal slime which would leave no record for the paleontologist. Numerous hypotheses have been advanced suggestive of the manner in which the emergence of simple living creatures from non-living systems might have occurred. The reader will find an excellent summary of these tentative theories in the volume edited by Baitsell (1), listed in the bibliography of the previous chapter. As knowledge concerning the nature of colloidal behavior increases, and new facts are brought to light regarding the

early evolution of the physical world, we have good reason to expect that a sound conception of the processes involved will be reached. For the present, however, it seems possible to do little more than draw certain negative conclusions in the hope of clearing away the false impressions that persist.

In the first place, we can be certain that life is not the mystical entity which the vitalist believes it to be. In the strict sense, the term life does not refer to an entity of any sort; it is merely a logical abstraction from living processes in general. This means that there is in reality no such thing as a life principle, but only organic systems which exhibit certain activities which we, by common consent, characterise as living processes. It is well known, for instance, that the several components of living protoplasm are the most commonplace of non-living chemical substances. Even when they have been absorbed and have taken their place as actual constituents of living protoplasm, the several chemical substances are not themselves alive. It is only the cell, or the living organism as a whole, which can perform the vital functions of metabolism and growth and thus may be said to live or be alive. The real problem of the evolutionist at this point is to account for the emergence of systems in nature so organised as to be able to perform these basic functions. No one claims that such systems arose suddenly from a miscellaneous collection of chemical elements and compounds. An extremely long period of physicochemical evolution, proceeding along more or less definite and orderly lines, led gradually to the natural emergence of living systems. The long and cumulative series of events most probably took place during the early part of the Archeozoic era as a normal phase in the evolution of the physical world.

In the second place, it is idle to suppose that the earlier types of living systems were unicellular organisms es-

sentially similar to those which now exist. These first attempts at living organisation must have arisen in a colloidal substrate much simpler than any sort of protoplasm of which we now know. The living cell which we regard as the basic unit of protoplasmic organisation is known to be exceedingly complex and must, itself, have evolved from other and simpler living systems. Millions of years of physicochemical evolution doubtless preceded the origin of the most primitive living systems, and perhaps no less time was required to bring the latter up to a simple cell-like stage. We have no way of knowing about the numerous other types of structure that must have come into being only to be swept away by the ruthless hand of natural selection. Apparently the cell type of organisation represents the sole survivor from these long ages of the dim and shadowy past. Its essential fitness to survive is shown by its almost limitless capacity to make the structural and functional adjustments to environment which an extensive evolutionary process requires. If the cell had not evolved, or having evolved had not survived, it seems likely that organic evolution would have been a brief and dreary failure. This critical stage was probably passed long before the close of the Archeozoic era, although, as previously noted, there is no direct fossil evidence on this point.

Whether the earliest cell-like organisms should be classed as plants, animals, or as plant-animals has not been finally settled as yet. As we know, most existing plants obtain their food materials by means of photosynthesis in which chlorophyll plays an important rôle, while most animals feed directly upon plants or other animals. It seems likely that the process of food manufacture underlying metabolism in the more primitive cellular organisms must have been much simpler than any at present employed. A few very simple existing bacteria are capable of the synthesis

of nutrient substances from inorganic materials without the action of chlorophyll. Since the latter substance is exceedingly complex, and doubtless was a long time in evolving, some biologists regard these lowly autotropic bacteria as the "living fossils" of primitive cell types. On the other hand, it may well be that simple plant and animal forms arose together as symbionts, the one supplying nitrogenous compounds and the other carbon dioxide.

Whatever the specific facts regarding early origins may be, we know that the plant and animal stems became definitely separated at a very remote epoch. Although genetically unrelated from this time forward, both stems have evolved side by side in a common environment in which the influences exerted by mutual interaction have been most marked. This separation probably came about before the close of the Archeozoic era, as indicated in Figure 3. While the beds of graphite found at this level may be mineral formations rather than organic remains, certain limestone deposits of the lower Proterozoic are generally regarded as the calcareous secretions of algae. This latter fact points clearly to the previous separation of the plant and animal stems in the Archeozoic era.

Remote Kinships

With these earlier events in mind, we may begin our brief survey of the evolution of the vertebrate stem with the unicellular stage of animal life. This type of organisation has little to offer in the way of progressive advance, since it is characterised by intracellular specialisation, and the cell itself is fairly definitely limited as to size. The existing protozoa may be regarded as the "living fossils" of unicellular types that came into being from time to time during the long period in which this level of organisation was dominant. At length, however, some of the unicellu-

lar organisms gave rise to spherical colonial types, and from these there finally evolved simple metazoan or multicellular types. A few of the colonial forms have persisted down to the present, while the "living fossils" of the simpler metazoan forms are represented among the coelenterates of to-day. The series of stages involved in the evolution of the simple metazoan plan of organisation from the protozoan are not revealed in the fossil record. Apparently the lime-secreting habit did not arise in the animal stem until much later—in Upper-Cambrian times—and this accounts for the general lack of fossils in the lower strata. The emergence of simple metazoan types probably occurred early in the Proterozoic era since there is evidence that the adaptive radiation of the invertebrates was well under way by the end of this era. In the Pre-Cambrian rocks, for example, the fossilized burrows and trails of segmented worms have been found, as indicated in the time table, Figure 3.

The primary characteristics of the simple metazoan type of organization must be drawn from the field of comparative morphology. The early metazoans, like their modern descendents, were diploblastic, their bodies being composed of two primary layers of tissue only. The outer layer, or ectoderm, was sensitive and contractile and thus performed the basic functions of a neuro-muscular system, while the inner layer, or endoderm, served as a primitive gut. The nervous system was of the diffuse nerve-net type such as one might expect to find in an organism possessing radial symmetry. These simple metazoans were not a mere collection of cells but constituted a genuine systemic unity in which the individual cells held a subordinate place. It is generally agreed that both the unicellular and simple metazoan types of organization represent definite evolutionary stages through which all higher organisms must have passed before advancing to more

complex levels. These stages are so fundamental that they are reflected in the early individual development of all higher types, including the human. The protozoan stage is represented in development by the unicellular beginnings of each individual; the simple metazoan stage by the gastrula phase of early embryogeny. The emergence of the simple metazoan plan of organization may be regarded as the most important single advance in the evolution of living systems. This rise to a new level of organisation carried with it almost endless possibilities in the way of structural and functional distribution of labor as later exemplified in complex multicellular organisms.

The structural plan of the primitive two-layer metazoans was highly generalised and thus possessed the capacity to become adapted in many divergent directions. It is usually held that the pro-chordate stem which ultimately led to the vertebrates, as well as each of the major invertebrate stems, arose directly from this group during the early part of the Paleozoic era. As we have noted, the adaptive radiation of the invertebrates was probably well under way by the close of the preceeding era, since fossil traces of segmented worms appear in the Pre-Cambrian rocks. The early Paleozoic is often termed the age of higher invertebrates, and doubtless witnessed the diversification of the marine invertebrates into the various phyla of segmented and unsegmented worms, the mollusks and the echinoderms. Fossil remains of the crustacean trilobites, which later became extinct, are found in abundance in the Cambrian rocks. The insects, spiders, and other classes of the Arthropoda, including most of the land-living invertebrates, apparently did not arise until late Paleozoic times. Each main stem radiating from the primitive metazoan stage advanced to a new level of organisation by the independent evolution of a triploblastic, or three-layer type of body. According to the

prevailing view, none of these invertebrate stems are in any way connected with the trend toward the human stock and, for this reason, they may be dismissed at once from further consideration.

Our interest at this point naturally centers in the gradual evolution of the chordate type from the primitive two-layer metazoan level, since this type finally gave rise to the vertebrate stem. No fossil remains have so far been found indicative of the series of stages involved in the early evolution of the chordate type. This is in no wise strange, since few if any of these transitional forms possessed the appropriate hard parts to be fossilized. The earlier pro-chordate forms were probably worm-like creatures that did not at first differ more greatly from the simple metazoans than some of the invertebrate types. It was the particular kind of divergence, with its higher evolutionary possibilities, that marked the pro-chordates out from these other types. The chordate plan of organisation centers around the notochord, a flexible rod-like structure running from head to tail and forming the basis of bilateral symmetry. The central nervous system lies above the notochord and is enlarged into a brain at the anterior or head end. The body is segmented, although less so than in many of the higher worms, and gill slits are present in either the embryo or the adult stage. As will be seen, these structural characteristics are carried through with modifications into the basic vertebrate pattern. The primary problem at this point is to discover, in so far as may be possible, how the chordate type evolved from the simple metazoan level.

The first step was probably taken when a jellyfish or other simple metazoan type gave up its free-swimming habits and took to crawling on the inshore sea bottom where food was especially abundant. A new impetus for fresh water forms to cling to the sea bottom may have arisen in connection with the Grand Canyon revolution

which quickened the pace of the streams and washed out to sea the simple metazoan types which could not evolve some sort of anchorage. Whatever the source of the clinging and crawling habit, we should expect that in process of time structural adaptations to the new environmental conditions would arise exemplifying a new trend in organisation. In general, bilateral symmetry and a long bodily axis running from head to tail are basic characters in organisms that crawl, while the simple metazoans possessed radial symmetry. As Gregory has suggested, the drawing together of the diffuse nerve net of the jellyfish into definite tracts would likely be associated with the beginnings of locomotion in a head and tail direction. Very early, perhaps, this changing two-layer type developed an intermediate layer of tissue, the mesoderm, as the several invertebrate types had done, and thus became triploblastic. A longitudinal groove of mesodermal tissue became transformed in time into the elastic notochord running from head to tail, forming the main bodily axis. From a similar groove of ectodermal tissue lying above the rudimentary notochord the main nerve cord with its paired spinal branches was derived. The mesodermal pouches lying on either side of the primitive gut became contractile and muscular and ultimately gave rise to the basic locomotor system in this new and elongated type. In some such manner as this, the primitive chordate evolved from the simple metazoan level as the evidence from comparative morphology tends to show. The evolution of the chordate stem took place at the same time that the diversification of the main invertebrate stems occurred and the distinctive chordate type probably arrived long before the close of the Cambrian epoch.

Although at first the primitive chordate was a small worm-like creature, in time a trend toward fish-like characteristics became established in a certain line which led

ultimately to the vertebrate stem. The series of changes involved in the evolution of the basic vertebrate type from the lower chordate level is not well exemplified in the fossil record. It is therefore impossible to trace the course of this important evolutionary trend with anything like exactitude. Nevertheless, some light is thrown upon the earlier phases of this advance by two existing types of "living fossils" more or less closely related to the general upward trend. The first of these is the worm-like Balanoglossus which possesses gill-slits, a rudimentary notochord, and a generalised nervous system in which the dorsal aspect is somewhat emphasized. This marine worm is the only living representative of the Hemichordata, or half-chordates, and is usually found burrowing in the sand at the bottom of shallow bays. A somewhat higher phase of chordate evolution is exemplified in certain of the tunicates, and particularly in the larval stages. The larva resembles a tadpole in general but possesses gill-slits, a well-developed notochord in the tail region and above this a prolonged neural tube with a brain-like vesicle in front. Most of these typical chordate characters are lost in the change to the adult stage at the present time, but this is regarded as indicating a marked degeneracy among existing types from the ancient tunicate pattern.

The trend toward fish-like characteristics in later chordate evolution is illustrated by the surviving lancelet, Amphioxus, and by the fossil armored fishes, or ostracoderms of the Ordovician and Silurian epochs. The Amphioxus is regarded as the "living fossil" of one of the direct descendents of the tunicates described above. It is somewhat less than two inches in length and is found partly buried in the sand or mud of most of the shallow continental seas. The notochord and the neural tube lying above it are much better developed than in any of the lower chordates, extending the full length of the body.

It possesses the usual gill-slits, dorsal, ventral and caudal fins, longitudinal folds on both sides of the body which suggest the possible origin of the paired fins of the primitive vertebrate, and numerous internal organs homologous with those of the typical vertebrate. Although the brain is relatively small and unspecialised, both cerebral and spinal nerves are present in pairs. It possesses a single median eye which is probably functionless, a single olfactory organ opening on the left side of the snout, but no trace whatsoever of an auditory organ. The fossil ostracoderms represent a still closer approach to the fish-like primitive vertebrate pattern. The brain is better developed than in Amphioxus, and shows the major divisions of the primitive fish brain, and paired organs for smell, vision, and balance are found in the head region. However, neither jaws nor paired fins from which the limbs of the higher vertebrates might be derived are present. The head is covered with a bony mask which foreshadows the vertebrate skull, and indicates that the specialised bone-cell had been evolved, either in this or in some ancestral type. In later forms the bone-cells invaded the tissues and led to the evolution of the vertebral column and internal bony skeleton of the vertebrates.

As might be expected, several of the more important structural characteristics of the chordate stage are clearly reflected in the embryonic phase of the individual cycle of the vertebrates which all derive from this common stem. The dorsal longitudinal groove passes through the notochord stage in the embryo before developing into the vertebral column in the adult. The tissues which finally develop into the bodily musculature of the adult grow out of the mesodermal pouches on both sides of the primitive gut. The central nervous system of the individual vertebrate develops from a longitudinal fold of tissue which comes to lie above the notochord, or rudimentary spinal

column. The gill-slits, of lower chordate origin, make their appearance early in the foetal life of the vertebrates, and certain of these are later transformed by normal growth processes into jaws and other facial structures. Many of the fundamental internal organs and systems of vertebrates first pass through a simpler chordate phase before taking on the more elaborate characteristics of the adult form. These and many similar structural changes occur in the foetal life of the human individual as well as in that of other vertebrates. It is evident, therefore, that man and his vertebrate allies have derived much of their fundamental bodily organisation from their lowly chordate ancestors. As we have said, the emergence of the simple two-layer metazoan level from which all higher types took their rise must be regarded as the greatest single advance step in organic evolution. The final emergence of the chordate plan of metazoan organisation, which reached its natural culmination among the vertebrates, deserves to be considered as the next genuinely crucial step in the general trend toward complexity of pattern.

Vertebrate Kinships

In all probability the first primitive vertebrates did not arrive on the scene much before Middle Silurian times. It is evident, therefore, that the events so briefly sketched in the two preceding sections occupied something like a billion years, or approximately two-thirds of the whole stretch of evolutionary time. This need not mean that the process of evolution went on at a slower rate during these earlier stages, for we must bear in mind that the larger steps had already been taken when the primitive vertebrate appeared. The emergence of the living from the non-living, of the cellular from the non-cellular, of the simple metazoan from the unicellular, and finally of the

chordate-vertebrate stem from the simple metazoan comprise the four major and genuinely crucial steps in organic evolution. That all these transformations should have occurred within the first two-thirds of the period elapsing since sedimentation began would seem to indicate a relatively rapid rate of change throughout. From this point onward, the problem of evolution is limited to the lesser changes occurring in connection with the adaptive radiation of the primitive vertebrates to various habitats. Many of the structural modifications thus brought about are important enough from the standpoint of vertebrate evolution, although not comparable to the four main steps mentioned above, when the whole evolutionary process is taken into account. The main trend from the primitive vertebrate level to the human stem leads directly through the fishes, amphibians, reptiles, and mammals as illustrated in the diagram of Figure 5. The birds represent a separate branch, taking off somewhat earlier from the reptiles than the mammalian branch, and hence may be entirely disregarded in tracing the vertebrate stem through to man.

The first primitive vertebrates arose from a generalised chordate type, probably closely related to the ostracoderms, although the immediate ancestral link has not been definitely identified as yet. While these early vertebrates may be thought of as fishes in the broad sense, they were in reality transitional forms leading to the typical fish organisation. As a rule the notochord persisted into the adult stage, and the internal skeleton was cartilaginous rather than bony. The existing lampreys and hags as well as the modern sharks or dogfishes are doubtless "living fossils" from among the primitive vertebrates of the Silurian epoch. The former group possess neither paired fins for locomotion nor the jaws of the typical fish and are known as cyclostomes because of their peculiar suctorial mouth. The sharks, both ancient and modern, come closer

in many respects to the typical fish pattern, but the skeletal structure is essentially cartilaginous in these types. The Devonian epoch is known as the age of fishes, and during this time the primitive vertebrates became diversified into the ganoids, lung-fishes, and other general types, and from certain of these the modern bony fishes ultimately arose. The basic vertebrate structure as represented in the higher Devonian fishes included the following important features: (*a*) a jointed bony vertebral column and ribbed internal skeleton, (*b*) a complex bony skull consisting of an outer shell and an inner braincase, (*c*) bony jaws derived from the front pair of gill-arches and overlaid with bony plates bearing teeth, (*d*) paired pectoral and pelvic fins with bony skeleton, and (*e*) paired sense-organs for smell, vision, and balance located in the head region. Thus we see that the basic vertebrate organisation, in which the principle of bilateral symmetry is dominantly expressed, had reached a certain stage of perfection among the fishes approximately half a billion years ago.

The vertebrate pattern, as exemplified among the fishes, had been evolved with special reference to a water environment. As the main groups of fishes became further diversified in marine and fresh water habitats, further specialisation along the same general lines was to be expected. It is evident, therefore, that some new and important environmental factor must intervene if vertebrate evolution were to accomplish more than the mere filling of the waters of the earth with diverse kinds of fishes. This novel factor must be of such a nature as to set up a trend among certain of the fishes toward a terrestrial or semi-terrestrial mode of life. The primary conditions for the establishment of just such a trend appear to have been furnished by the semi-aridity of the Devonian epoch, or age of fishes. The sediments and fossil vegetation of the period indicate the prevalence of alternating flood and

dry seasons at this time. During the dry season of the year, the streams of the broad river plains were often reduced to mere rivulets, marshy water holes, or dried up beds. Such a condition would exert a profound influence upon the fresh water fishes by placing a premium upon an air-breathing mechanism of some sort and upon limbs for land locomotion. The evolution of the necessary structures in certain types of fishes would be expected on the basis of adaptive radiation involving rigorous selection through a long period of time. These and other facts favor the view that the gradual evolution of amphibians from some generalised fish type took place in the river swamps during the Devonian epoch.

As is well known, the ganoids and the lung-fishes were predominant general types during late Silurian and Devonian times. Both types of fishes possessed, in addition to gills, a swim-bladder or lung for air-breathing, derived from one of the earlier gill-pouches. The modern descendants of certain of these general types now inhabit semi-arid tropical regions under conditions roughly similar to those of the ancient Devonian swamps. In some of the existing ganoids the air-bladder arises from the lower side of the gullet and is a paired structure as in the amphibian lung. The transition from fish to amphibian, in so far as the air-breathing mechanism is concerned, thus appears to have been a relatively simple evolutionary step. The origin of the amphibian locomotor apparatus from the paired pectoral and pelvic fins of the fish involved a more radical modification. However, the lobe-finned ganoids of the early Devonian epoch possessed fins with broad basal lobes, a bony skeleton, and an outer fringe-like expansion, and from these fins limbs for land locomotion might well have been derived. The arrangement of the bony elements of the fin was strikingly similar in some instances to the bones of the primitive amphibian limb, as

illustrated in Figure 4. The lobe-fin, which contrasts sharply with the ray-fin of many ancient and modern fishes, may thus be regarded as transitional in character. Perhaps, at first the limb-like fins were useful mainly in getting back into the water when a given marshy pool dried up, but in time they became modified so as to favor land locomotion in general. When all the evidence is taken into account, it seems highly probable that the amphibians arose from the lobe-finned ganoids of the Devonian swamps, or some closely related type, under the conditions of semi-aridity then prevailing.

The transitional stages from fish to amphibian had been passed through before the close of the Devonian period, since fossils of well-developed amphibians are found in the Lower Carboniferous rocks. As might be expected, the primitive amphibians were more or less fish-like in appearance and did not much resemble such common modern types as frogs, toads, and salamanders. The limbs were short and stood out from the body in such wise that the gait was slow and clumsy. Nevertheless, they represented the beginnings of the tetrapodal or four-limbed organisation in a generalised form capable of diverse modification later among the higher vertebrates. The unpaired fins of the ancestral lobe-finned fishes, which were strictly aquatic specialisations, were lost. The amphibian foot probably began as a two-toed organ on the outer side of which other digits arose from time to time until at length the five-digit foot became standardised. The earliest amphibians are called Stegocephalia, because of the enamel-like armour over the head region, but this was gradually lost as the type advanced. They possessed, in addition, a complex outer skull of many bones, and among these were included the twenty-eight bones corresponding to those of the human skull. The upper jaws, palate, and cranial base of the higher vertebrates can be identified in the bony struc-

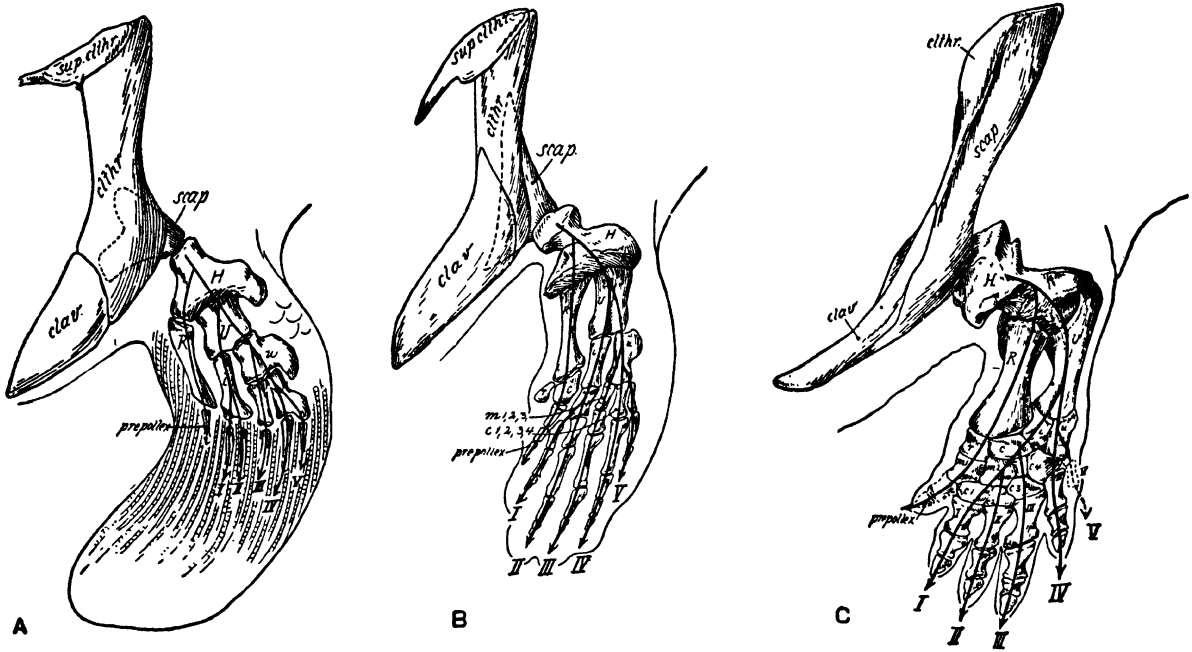


FIGURE 4. Comparison of pectoral fin of Devonian lobe-finned ganoid (A), Permian amphibian (C), and hypothetical intermediate stage (B). (From Gregory, W. K., in "Human Biology and Racial Welfare." Paul B. Hoeber, Inc., 1930.)

tures of the inner skull. The teeth of the primitive amphibian were similar to those of the lobe-finned fishes rather than like the socket type of the later mammals. The internal gill structures were lost and a well-developed middle ear gained in the transition from fish to amphibian. Thus we see that the full amphibian plan of organisation represented numerous important advances in several directions toward the generalised pattern of the higher vertebrate type.

The emergence of the more adventurous air-breathing fishes from the water by the adaptation of the paired fins for land locomotion proved to be an event of momentous consequences. In fact, this initial invasion of the land by certain of the fishes must be regarded as the greatest single step in vertebrate evolution. It made possible the adaptive radiation of the vertebrates into terrestrial, arboreal, and aerial life zones. The amphibians never became more than partially adapted to terrestrial existence, but they gave rise to the reptiles in early Carboniferous times, and the latter were true land types. The primitive reptiles laid their eggs on land and dispensed entirely with the gill-breathing larval stage of their amphibian forbears. This change in mode of development gave rise to a new type of egg which is characteristic not only of this group but of all the higher oviparous, or egg-laying animals. In addition to the germinal elements, the reptilian egg contains nourishment enough to supply the young until they hatch in a fairly well-developed condition. The embryo is protected from sudden jars and temperature changes by the amnion, a sac-like membrane filled with fluid which completely surrounds it. Embryonic respiration is accomplished by osmosis through a second membrane, the allantois, which lies immediately beneath the porous shell. As will be seen, the evolution of the membranous egg by the first land forms made the gill-breathing larval stage

no longer necessary and enabled them to become wholly independent of the ancestral waters. The primary impetus behind the evolution of the reptiles seems to have been the long period of aridity in the Carboniferous epoch, immediately following the semi-arid conditions which had previously stimulated amphibian evolution during Devonian times.

The primitive reptiles were similar in general structure to their amphibian progenitors and contemporaries. This is true to such an extent that it is often difficult for the comparative anatomist to distinguish definitely between the early fossils of the two classes. In both groups the limbs were short and sprawled out sidewise, while the body was rather massive in build and was suspended close to the ground. Among the reptiles, however, this primitive plan of organisation was soon displaced by more efficient types. The adaptive radiation of the reptiles took place during the Upper Carboniferous and Permian epochs, and several divergent trends in structural modification became established during this time. Certain reptilian stems evolved along lines which finally culminated in the gigantic dinosaurs that ruled the land during the greater part of the Mesozoic era, or age of reptiles, and then became extinct. Some of the dinosaurs were carnivorous while others were herbivorous. Certain of the latter group were especially large, measuring more than eighty feet in length and weighing as much as forty tons. Flying reptiles also appeared, and some of these attained a wing spread as great as thirty feet. From certain of the reptiles that returned to the water and became amphibious our modern crocodiles are descended. The lizards, snakes, and turtles of to-day are the "living fossils" of still other ancient reptiles. One important offshoot from the reptile stock led to the birds in Middle Mesozoic times. The upward trend in vertebrate evolution is represented, however, in

none of these various branches, but rather in a small and lowly type which ultimately gave rise to the mammalian stem.

These early mammal-like reptiles were a generalised form which arose directly from the primitive reptilian stock during Permian times. According to Romer, few of them were larger than the common rodents of to-day. While they still retained many reptilian features, they represented a distinct trend toward mammalian characteristics, and may be regarded as marking an important transitional stage. They possessed a light bodily build and their relatively long limbs were brought up well underneath the body after the manner of the typical mammal. This was especially true of the cynodonts, or dog-tooth reptiles of the Triassic epoch, as the fossil evidence clearly shows. In sharp contrast to the amphibians and primitive reptiles, this new type was built for active land locomotion, and in walking tended to place the weight more on the ends of the toes. They show a reduction in the number of phalanges, or bony segments in the different toes of the fore and hind feet, to the number found in the typical mammal. As Gregory (10) has pointed out, important mammalian characteristics are also observable in the skull, jaws, and teeth. The dentary, or tooth-bearing bone of the jaw, showed a progressive adaptation toward the mammalian type, and each tooth was set in a distinct socket. Instead of an indefinite replacement of teeth, as in earlier types, only two sets appear corresponding to the milk and permanent teeth of the mammal, and like the latter, differentiated into incisors, canines, premolars, and molars. These and other similar facts indicate clearly that the gap between the primitive reptiles and the early mammals is bridged by the mammal-like reptiles.

The first primitive mammals arose from the cynodont stem in late Permian or early Triassic times. They were

small creatures covered with hair or fur instead of reptilian scales, and nourished their young by the secretion of the mammary, or milk glands. They were equipped also with a heat-regulating mechanism for keeping the body temperature relatively high regardless of climatic conditions. This may have been inherited in a rudimentary form from their cynodont ancestors, since these reptiles carried the body well off the ground which is one of the primary conditions for the development of such a mechanism. The improved lung, active diaphragm, cutaneous sweat glands, and body hair of the mammal suggest, however, that the homoiothermal or warm-blooded condition originated after the mammalian grade had been reached. The external causes responsible for the establishment of the trend in this direction seem to be the general aridity of the climate and the extensive glaciation of the Permian and Jurassic epochs. As Lull has pointed out, the aridity would make possible the evolution of warm-bloodedness by placing a premium upon speed of locomotion. In general, speed of movement and a relatively high and constant body temperature are associated with a high metabolic rate in the organism. Moreover, a premium would be placed upon the retention of bodily heat by the extensive periodic glaciation of the Permian epoch, occurring especially in the southern hemisphere between latitudes 20 and 35 degrees. These geological facts thus agree with the fossil evidence which favors the view that the primitive mammals arose from the cynodont stock in Africa.

The early mammals were still primitive in many respects in comparison with most of their descendants of to-day. They lived principally upon insects, and doubtless their small size and fleetness of foot saved them from the predacious ruling reptiles that were rapidly spreading over the land. They laid large reptile-like eggs, although they suckled their young after hatching. This stage of mam-

malian evolution is represented among existing types by the monotremes, or egg-laying mammals of Australia—the duckbill and the spiny anteater. In time a trend toward the placental type of reproduction, in which the fertilised egg develops within the mother, was established and this ultimately became the typical mammalian method. This change involved a reduction in the size of the egg, the retention of the fertilised egg by the female, and the supplying of the growing embryo with nourishment and oxygen by means of the placenta, or "after-birth." An intermediate stage between the egg-laying mammals and the more modern placental mammals is represented by the marsupials of the Jurassic epoch. The marsupials, or pouched animals of to-day, such as the opossum and kangaroo, are the "living fossils" of this evolutionary stage, as indicated in Figure 5. They possess a primitive placenta, but the young are born very immature, and must be carried about by the mother in a pouch underneath the body. The young opossum, for example, is less than an inch long when born, but makes its way to this pouch and attaches itself to a nipple. The full placental organisation was reached in the insectivores of the Lower Cretaceous epoch, and this group may be considered as the ancestral prototype of all the placental, or higher mammals. It seems likely that this basic type evolved in Asia from whence their progeny migrated to Europe, and to North America over the Behring Straits land bridge, near the beginning of the age of mammals.

The adaptive radiation of the higher mammals, as illustrated in Figure 1, began during late Mesozoic times. The spread of the mammals was doubtless made possible, in part at least, by the passing of the predacious reptilian horde from the scene. The ancestral insectivores were probably arboreal, but their progeny spread rapidly into other life zones and in time became markedly diversified

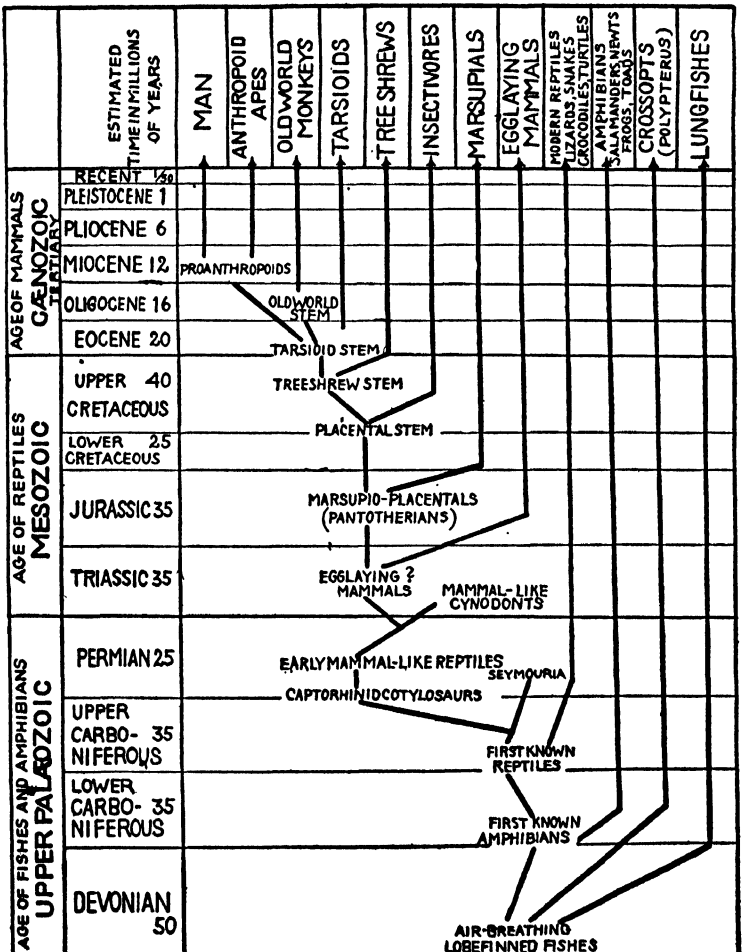


FIGURE 5.

STRUCTURAL STAGES IN RISE FROM FISH TO MAN

Starting from upper right-hand corner, "living fossils" form a series that gradually approaches man in general structural plan. Each "living fossil" is also a surviving witness of a corresponding stage in past ages. (From Gregory, W. K., in "Human Biology and Racial Welfare." Paul B. Hoeber, Inc., 1930.)

in structure. The archaic mammals of early Tertiary times comprised one of the first groups to become highly specialised. Some of these were carnivorous and of medium size, while others were herbivorous and of elephantine proportions, with horn-like prominences on their heads and very long tusks. In general, this group possessed a relatively small brain and many of them were otherwise ill-adapted to survive the competition that arose. Most of the archaic mammals became extinct without leaving descendants before the close of the Eocene epoch. Other branches of the Insectivora stem gave rise to the modern mammals which came into prominence about the beginning of the Tertiary, or age of mammals. These may be roughly grouped into four grand divisions: the clawed mammals, the hoofed mammals, the cetaceans or water mammals, and the primates. Each of these larger groups includes numerous families, and species, many of which are well known to us. In tracing further the genetic basis of the human stem, all of the mammals except the primates may be disregarded, since they represent collateral evolutionary lines.

The adaptive radiation of the vertebrate stock as a whole, as sketched in the present section, required no less than a quarter of a billion years. The evolution of the primitive mammal from the lobe-finned ganoids of Lower Devonian times through the amphibian, reptilian, and mammal-like reptile stages must have consumed something like one hundred and fifty million years of this long stretch. Almost another hundred million years were consumed in bringing the primitive mammal up to the level of the modern placental organisation. From this point onward the evolution of the human stem is definitely connected with changes which were brought about by the adaptive radiation of the primate order of placental mammals. In our discussion of vertebrate evolution we have been

able to notice only general aspects of such structural changes as characterised a new level of organisation. A more detailed discussion of the latter topic will be found in a recent volume by Goodrich (8) and in other standard treatises.

Numerous special lines of progressive advance running through the several stages from fish to man are of special interest to the student of human evolution. A few books dealing with certain of these trends have been listed in the bibliography. A survey of the evolution of the skeletal, muscular, and sensory aspects of the head region, from fish to man, has recently been made by Gregory (10), one of the leading American comparative anatomists. Another volume by the same author details the various stages in the evolution of the human teeth. A brief summary of the evolution of the vertebrate nervous system will be found in the volume by Herrick (11) and more detailed treatments in the standard manuals. In general, a progressive trend toward increase in the weight of the brain relative to body weight, and also relative to the weight of the spinal cord is clearly shown. Many of the more important stages in the evolution of the organs and systems of the several vertebrate levels are reflected in the embryonic development of the higher mammals, including the primates and man.

Primate Kinships

The primate stem arose from the highly organised insectivorous mammals of the Cretaceous epoch along with the other main placental lines. The trend among certain of the Insectivora toward the primate type is well illustrated by the ancient tree-shrews and their modern descendents, as indicated in Figure 5. These ancestral forms were small arboreal creatures, extremely agile in move-

ment, and capable of sitting on their haunches and eating food held in the fore paws. They were relatively large-brained animals and possessed a better developed neopallium than their mammalian contemporaries. The emergence and elaboration of the neopallium, or new brain mantle, with special centers for visual, auditory, kinesthetic and tactual sensitivity, from the archipallium, or primitive olfactory mantle represents a general mammalian trend. It carried with it a shift from the dominance of smell to the dominance of these other senses, particularly vision, and reached its natural culmination in the primates. It is clear that these other senses would be of more use than smell in such basic life-activities as searching for food and escaping enemies by flight in an arboreal existence. The brain of the tree-shrew distinctly foreshadows the primate trend in this regard. The earliest fossil primates appear in the Lower Eocene rocks of North America. It is believed by some, however, that the lower primates evolved in northern Asia, probably in late Cretaceous times, and migrated to North America over the Behring Straits land bridge. The fossil fauna of the two continents are markedly similar and, with the passing of the great reptilian horde, migrations in both directions doubtless occurred as the modern mammals spread rapidly over the land. The circum-polar regions were then heavily forested and furnished an ample food supply for arboreal types. The climate was semi-tropical and hence also favorable to the adaptive radiation of the primates.

The pro-simian, or lowest primate level had probably been reached by the opening of the Cenozoic, or age of mammals. This stage is sometimes called the lemuroid or tarsoid level since it included the ancient progenitors of the lemurs and tarsiers of the present time. These early primates inherited from their tree-shrew ancestors the basic structural equipment of the higher mammalian or-

ganisation in a generalised form capable of adaptive specialisation. Several of the more distinctive primate characteristics had also begun to appear. As a rule the digits of the feet were provided with nails instead of claws and the rather massive great toe was set off at an open angle from the other digits, as might be expected in an arboreal type. This modified foot contrasted sharply with the hoof, paw, and claw of other great mammalian lines, and meant that an important step had been taken toward the development of quadrumanal, or four-handed locomotion. Instead of the numerous mammary glands of the typical mammal, these early primates possessed only a single thoracic pair, with perhaps an additional pair on the abdomen. The lemuroids still had a dog-like muzzle, but in the tarsoids the snout was so reduced as to give to the face a monkey-like expression. With the recession of the snout in the tarsoids, the large well-developed eyes moved around into a more frontal position thus increasing the range of binocular vision. The enlargement of the visual and other centers of the neopallium, which had begun in the ancestral tree-shrews was carried one step further in the lower primates. As Professor Elliot Smith has pointed out, it was this unique brain expansion that set off the early primates from all other mammals most distinctly.

The primitive monkeys representing the second, or simian primate level evolved from the tarsoid branch of the pro-simian stem in North America in late Eocene or early Oligocene times. The monkeys were somewhat larger than their tarsoid ancestors and possessed a more human-like face. The earlier types at least retained the pronograde locomotion of the lower primates, although quadrumanal specialisation had proceeded further. The hands and feet were well-adapted for grasping objects and the former were beginning to be liberated from locomotor

functions. The tendency to sit upright and manipulate food and other objects with the hands became more and more natural and fixed. The neopallium also showed a marked development in the visual, auditory, motor, and associative regions, as illustrated in Figure 7. Monkeys are by nature climbing and leaping creatures in which delicate bodily balance and superior visual discrimination are most essential. In modern monkeys at least, convergence and conjugate movements of the two eyes, and stereoscopic or three-dimensional vision appear to be about as well developed as in man. The experimental evidences (7) show clearly also that the capacity to distinguish the form, size, pattern, and color of objects is much superior to that of any of the common mammals. The growing dominance of visual space perception in the monkey is precisely what might be expected to occur in the evolution of active tree-living types. From the beginning of Oligocene times onward, the fossil record of primates in North America is completely barren, showing that the primitive monkeys either left their ancestral home or perished. Some of them apparently migrated to South America, over the Isthmian land bridge or its equivalent, and there became diversified into the several Platyrrhini, or broad-nosed types with prehensile tails. Others migrated in time to Europe and Africa, over the Atlantic land bridge, and from these were derived the Catarrhini, or narrow-nosed Old World monkeys.

The pro-anthropoid, or third primate level arose from among the Old World monkeys of northern Africa in early Oligocene times. The best fossil representative of this stage of primate evolution is Propliopithecus, discovered among the Fayûm fauna of Egypt. Although differing in many details from the ancestral form, the modern gibbon embodies the more essential features of this new type. The gibbon is somewhat larger than the average monkey,

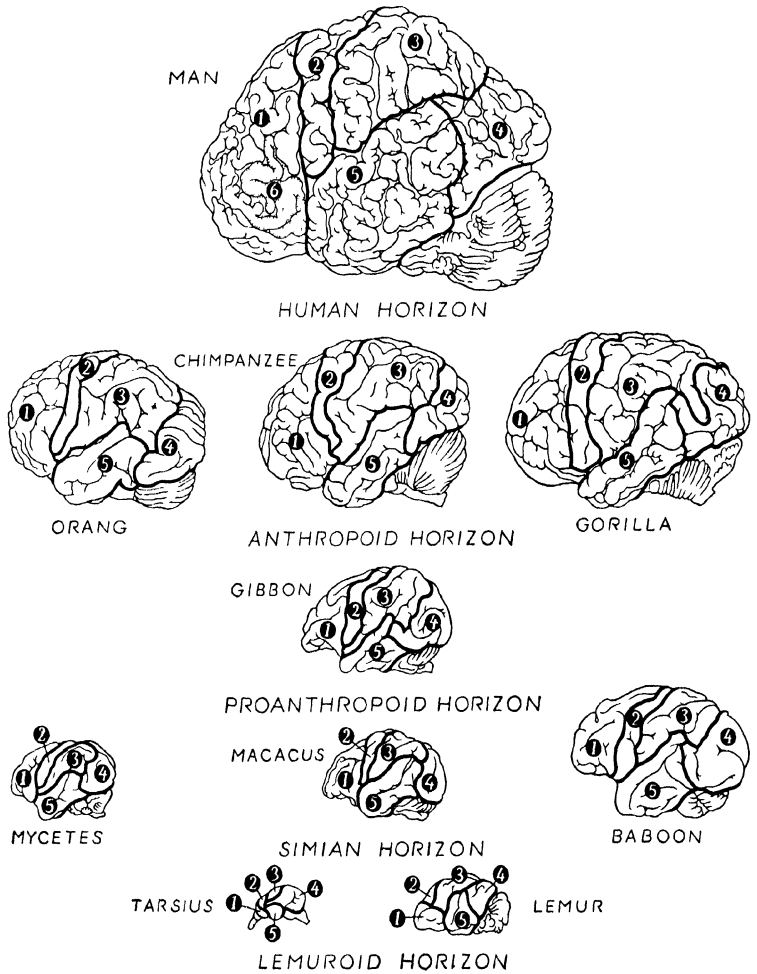


FIGURE 7. PRINCIPAL PRIMATE HORIZONS, SHOWING THE EVOLUTIONAL EXPANSION OF THE NEOPALLIUM

Each brain reduced to two-sevenths actual size. The progressive expansion of the association area (region 1) is clearly demonstrated in ascending from tarsius to man. Key: 1. Association region, 2. Motor region, 3. Sensory region, 4. Visual region, 5. Auditory region, 6. Speech region. Adapted from Tilney. (From Tilney, F., "The Brain from Ape to Man." 2 Vols., Paul B. Hoeber, Inc.)

is slender in bodily build, and has arms that are so long that they touch the ground when the animal stands erect. Instead of running along the upper side of branches, the gibbon hooks his hands over a branch, hangs beneath it, and hurls himself through the air from tree to tree. This method of locomotion is termed "brachiation" and requires strong and extremely long arms as well as superior motor control. Modern gibbons have been known to leap as far as forty feet, while half that distance is not at all uncommon. This speedy mode of moving through the trees probably evolved gradually in a line of monkeys which had already developed great skill in manipulating objects with the hands. As might be expected, this new mode of locomotion brought about marked changes in the bodily organisation of the ancient gibbon-like primates. The lengthened arms and the long, narrow hook-like hands of the gibbon are obviously associated with the settled habit of brachiation. Of much more importance to the student of human evolution, however, is the fact that brachiation led to the adoption of an upright posture in tree life. In brachiating the body is held upright, at right angles to the general plane of forward motion, in sharp contrast to the pronograde position taken by the simians and pro-simians in locomotion. When on the ground the gibbon walks erect like a man but, as a rule, with arms extended above the head, and not on all fours like the monkeys and earlier primates.

The development of upright posture in the early Oligocene pro-anthropoids proved to be an event of supreme importance in the chain of circumstances leading to the emergence of the human stem. As pointed out by Sir Arthur Keith (12), long-continued brachiation brought about a complete reorganisation of the bodily structures along fundamental lines. The monkey, like the common quadrupedal mammals, has the chest flattened from side

to side, while it is flattened from before backward in the gibbon and later orthograde primates. This meant a change of the first order in the entire respiratory mechanism. The visceral organs of the monkey are supported by flat muscles passing along the lower surface and sides of the body, and when the animal is placed in an upright posture these organs tend to sag to the lower part of the abdomen. The change to arboreal bipedism in the gibbon required the evolution of the human type of supporting musculature for the viscera. The tail which had functioned as a balancing organ in the monkey became useless, since the center of gravity of the body had now shifted, and it was lost to the gibbon and to all higher primates. The muscles which had been used to depress the tail gradually spread out across the pelvic region forming a hammock to support the viscera. Numerous changes occurred also in the spinal column and in the associated musculature. The base of the skull, which is continuous with the line of the backbone in the monkey, shifted to a position almost at right angles to the spinal column so that the head was poised after the human fashion. Many other less noticeable but equally important changes were brought about in various parts of the body. This general structural reorganisation, resulting from the evolution of upright posture in the brachiating pro-anthropoids, was passed on directly to the great apes and to man.

Some of the pro-anthropoids migrated in time from northern Africa to southern Asia over a continental land bridge which has since disappeared. No fossil form truly representing the generalised anthropoid type from which the great ape and human stems were derived has so far been discovered. Dryopithecus, found among the Middle Miocene fauna of the Siwalik Hills of northern India, probably comes nearest to embodying the essential characteristics of this type. Gregory (9) has emphasized the like-

ness between the teeth of Dryopithecus and those of the great apes and primitive man. However, Osborn and others regard this type as a representative of the pro-ape stem rather than of the generalised anthropoid group from which the ape and human stems were derived. The ancestral anthropoids differed from the ancient gibbons in numerous ways, and especially in a marked general increase in size. As we have seen, an increase in bodily size within a group of animals is one of the common evolutionary trends. This trend had been more or less gradual in the primates from the pro-simian to the pro-anthropoid level, but in passing to the anthropoid level bodily size was more than doubled. This increase led to the abandonment of brachiation in the high tree-tops after the manner of the gibbon, since the additional weight tended to keep the anthropoids closer to the ground. There is no need to suppose that the ancient gibbons, which were immediately ancestral to the generalised anthropoid stock, had specialised in brachiation to the extent of the modern gibbons. The slender body, lengthened arms, and especially the hook-like hand of the gibbon doubtless represent in part changes which occurred after the modern gibbon stem had become definitely set off from the stock leading to the anthropoids. Brachiation must have been carried far enough in this ancestral stock, however, to bring about the bodily reorganisation mentioned above which so sharply marks off the gibbons, great apes, and man from the monkeys and other primates.

The divergence of the pro-ape and pro-human stems from a common anthropoid stock probably took place either in late Oligocene or in early Miocene times. Central Asia is generally regarded as the center of dispersion of the anthropoid stock. The three great ape types became diversified from among the anthropoids that remained in a forest habitat, while man evolved in time from the an-

thropoids that descended from the trees and lived upon plain and plateau. The orang-utan was the first of the apes to become definitely set off from the pro-ape stem. The orang retained the habit of brachiation more than the other apes, and migrated south-east, finally finding a permanent home in the dense forests of Borneo and Sumatra. The chimpanzee and gorilla types separated considerably later, as indicated in Figure 8; both turned southward and finally settled in different parts of West Africa. The migration of the apes southward was doubtless due to their attempts to maintain themselves in forest-clad regions. For the increasing aridity of central Asia in Oligocene and Miocene times led to the restriction and gradual extinction of forests in a southerly direction.

The pro-human anthropoids stayed on in central Asia as the forests dwindled and thus became definitely separated from the migrating great ape stock. It is generally believed that the final separation occurred as a result of the Himalayan uplift, in Miocene times, which cut off the forest-clad regions to the south from the central Asiatic plateaus. This separation of forest and plateau types included not merely the primates but the mammals in general. It is especially noteworthy that the highest evolution among the latter as well as the former occurred on the plateaus of central Asia. The colder climate and the more difficult conditions of life contrasted sharply with the tropical forests to the south and helped to bring about a higher level of adaptive organisation. Osborn holds that the separation of the plateau mammals from the forest types took place in the Oligocene epoch or earlier. His extensive studies of mammalian phylogeny seem to show that the trends in skeletal form, teeth, limbs, feet, and other characters which distinguish these two great groups, were established long before Miocene times. He places the separation of the pro-ape and pro-human stems at about

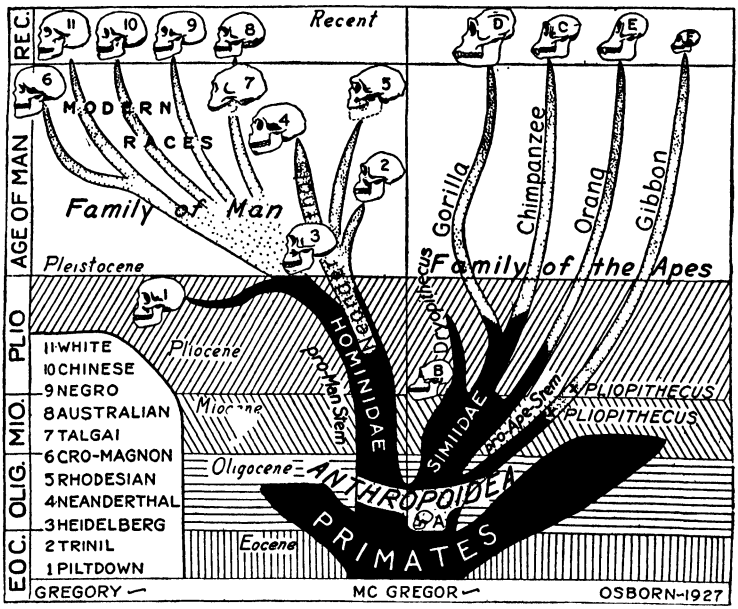


FIGURE 8. OSBORN'S PRESENT THEORY OF THE ASCENT AND PHYLOGENY OF MAN

Left: Family of Man (*Hominidae*), dividing into the Neanderthaloid and modern racial stocks; present geologic location of the Piltdown, Heidelberg, Trinil, Neandertal and Rhodesian fossil races. Right: Family of the Apes (*Simiidae*), including the Pliocene and Miocene dryopthecoids nearest the ancestral stock of the Anthropoidea, also the lines leading to the gorilla, orang, chimpanzee and gibbon. Below: Anthropoidea, the common Oligocene ancestors of the *Hominidae* and of the *Simiidae* A, Propliopithecus of the fossil fauna of Fayûm, Egypt. (From Osborn, H. F., "The Discovery of Tertiary Man," Science, Vol. 71 (1930).)

the middle of the Oligocene epoch as shown in Figure 8. Although the precise time may be open to question, there is general agreement as to the chain of causes which finally led to the emergence of the human stem.

The separation of the pro-ape and pro-human stems doubtless took place gradually. The passing of the forests due to the increasing aridity of the climate was not a

matter of centuries but of thousands of years. There is good reason to believe, also, that the most progressive of the anthropoid stock became the nucleus of the pro-human stem. It is generally true that the most highly evolved sub-types of a group tend to remain nearest to the center of dispersion. The general drift southward toward the densely forested regions was thus from among the most conservative and backward varieties. This would mean the selection of the progressive strain which remained behind to be the immediate ancestors of the pro-human type. As the forests dwindled new sources of food supply had to be discovered in the grasses and seeds of the plains. The sub-tropical climate also became temperate, or cold with the passing of time. As the selective process became more rigorous, only the strong and resourceful anthropoids which had become more or less adapted to a semi-terrestrial life were able to survive. The final separation of this progressive group from their relatives which had migrated southward marked the transition to the pro-human type.

Chapter III

WHEN ANTHROPOID BECAME HUMAN

We have passed in review, in the preceding chapter, the main series of events which led to the eventual evolution of the human, or pro-human stem. The series is cumulative as a whole and represents the more important genetic kinships that link mankind to the larger living world. However, the story of man's evolution is still incomplete for, as we shall see, the early pro-human types were essentially ape-like rather than human. The emergence of the pro-human stem, some sixteen to twenty-five million years ago, marked merely the beginning of the strictly human trend. This important trend, initiated by the final separation of the pro-ape and pro-human stocks, could lead to the human type only by running its natural course. By far the larger part of the time that has since elapsed was consumed in further evolutionary changes before a being that might properly be called human came into existence. The pro-human stock had effectively entered into a new life zone by remaining on the plains and plateaus as the forests receded. Their refusal to leave the ancestral home amounted in the end to an adaptive radiation from an aboreal to a terrestrial habitat. This course of events brought into active play the forces of natural selection in the evolution of more or less fundamental structural adaptations to meet the new environmental conditions. The trend set up by such a major shift in habitat is likely

to be long-continued and to eventuate in types markedly different from the ancestral form. We should not be surprised, therefore, either by the final appearance of distinctive human characteristics in the pro-human stock, or by the exceedingly long time required for these to become manifest.

The existing apes are generally recognised as being much less far removed from the common anthropoid type than even the most primitive man. The pro-ape stock migrated with the retreating forests and thus were not required to shift to a new life zone as their pro-human cousins had done. The structural modifications involved in the later diversification of the stock into the orang, chimpanzee, and gorilla types were accordingly less fundamental in nature. As we have seen, the great apes had inherited the upright bodily posture from their gibbon-like ancestors. The increase in weight which marked the rise to the anthropoid level seems to have continued, long after the divergence, in the pro-ape stock. The orang and the gorilla in particular possess large, bulky bodies, the adult gorilla often weighing as much as 400 pounds. This increase in size became a hindrance in time to successful arboreal life and tended to force the great apes to leave the high tree-tops and to keep nearer the ground. Previous to this, however, they had evolved the long arms, short legs, and other specialisations which are naturally associated with long-continued brachiation. The orang and the chimpanzee have remained for the most part in an arboreal habitat, although they have lost the ability to brachiate effectively.. The gorilla has practically become a ground-living type, rarely climbing higher than ten feet or so in trees, and always sleeping on the ground. The great apes can stand erect after a fashion, but they all walk or run in a clumsy manner. They usually adopt a modified pronograde posture in walking, the knuckles of the

hand touching the ground to serve as support, and when speed is demanded they are likely to drop down on all fours. This belated attempt of the apes to become in part ground-dwellers has not been very successful. The foot and limb structures had become too highly specialised for arboreal life in connection with long-continued brachiation to permit of an adequate evolutionary adjustment to ground-living conditions later.

There is no reason to suppose that the earlier pro-human forms differed in their general features in any marked way from their pro-ape cousins. They led a semi-terrestrial life at first and broke sharply with their older arboreal habits only when they were finally forced to do so. The trend in this stock toward strictly human characteristics was thus gradual and led through a long series of transitional stages. The fossil record reveals almost nothing to date in the way of intermediate types from the point of divergence to the first human remains of late Pliocene times. However, the region of central Asia, where such types would be most likely to occur, has not been extensively explored as yet. Numerous fossil primates have been recovered in connection with the work of American paleontologists in the Gobi desert, but none of these represent pro-human transitional types. The general trend in evolution from ape to man is indicated, however, by many lines of indirect evidence. The most important of these, perhaps, is human embryology. As might be expected, certain of the more outstanding structural modifications that took place are clearly reflected in the earlier stages of development. The comparative morphology of the apes and primitive man offers another valuable line of evidence. Much knowledge regarding the evolution of the bipedal locomotor organs of man can be drawn from the analysis of limb and foot types. Some insight into the behavioral aspect of the human trend can be gotten from the studies

that are accumulating on the comparative psychology of ape and man. When the facts drawn from these and other fields of evidence are brought together, a fairly adequate account of the events leading to the final emergence of the human type can be given, even in the absence of fossil material.

The primary aim of the present chapter will be to show how the evolution of man from the anthropoid level came about. Before dealing directly with this problem it will be necessary to set forth more definitely the complex of characters represented in the common ancestor of ape and man. By distinguishing the general anthropoid complex from the specific human factors, which appeared later, we will be able to set the proper limits of the present problem. As we shall see, many characters usually regarded as strictly human are in reality anthropoid, being possessed alike by the great apes and man. The basic attributes of the common anthropoid ancestor of ape and man can be revealed by stripping off the specialisations which arose in each stock after the divergence of the two stems. This analysis can be simplified by making the usual assumption that such factors as are common to the great apes and man at present belong to the basic anthropoid complex. The validity of this assumption rests upon the improbability that these common characters arose independently in two lines so closely related. In applying this principle, a certain allowance must be made for the later perfecting of some of the common characters in the two parallel stocks. This aspect of the problem, indicating what still remains to be accounted for in the evolution of man, will be dealt with in the first section. The structural specialisations which may be regarded as distinctively human in character will be enumerated and the manner of their evolution outlined in the second section. The remainder of the chapter will be devoted to a discus-

sion of the part played by these strictly human traits in the beginnings of cultural evolution.

Basic Anthropoid Characters

The anthropoid level represents the cumulative heritage of the general trend toward the human type up to the time when the pro-human stem diverged. Many of the characters involved must be common, therefore, not only to other primate levels but also to an ever-widening scope of animal life as we pass backward in time. However, we shall mean to ignore the matter of origins, in the present connection, since our primary purpose is merely to see how far evolution toward man had proceeded up to this critical point. Note has already been taken of the origin of many of these characters in the preceding chapter. We wish now to enumerate the common characteristics of ape and man, which we shall regard as belonging to the common ancestor of the pro-ape and pro-human stems. Obviously anything like a complete survey of the structural and functional capacities of the anthropoid level cannot be attempted within the limits of the space here available. The discussion will be restricted, therefore, to the more outstanding factors of the general anthropoid complex which relate more or less directly to the human type. Most attention will be given to those common characteristics of ape and man which are likely to be regarded as belonging solely to man. The aim of this analysis will be not so much to lower the barrier between man and anthropoid as to bring into relief the facts upon which the genuine distinctiveness of man depends.

First of all, we must regard the general bodily organization of man as a direct heritage from the common anthropoid ancestor of the pro-ape and pro-human stems. The similarity in this respect is so great that the comparative

anatomists have been known to argue for years as to whether a given fossil should be classified as ape or primitive man. As Sir Arthur Keith (12) has pointed out, every bone of man's body is found in the ape and presents the same leading features, differing only in proportion, size, or other detail in the two cases. The same may be said of the internal organs and systems upon which the fundamental physiological reactions of the organism depend. The vertebral column of the ape differs from that of man, according to Sontagg (14), mainly in its curvatures, in the character of certain of the bones, and in the number of rib-bearing elements. Man has a typical anthropoid neck except for the fact that it is somewhat longer and has less well-developed musculature. The tail is absent in both ape and man, and the former tail muscles had spread out to form the pelvic floor which supports the viscera long before the anthropoid level was reached. A vestigial tail appears in the embryonic development of both ape and man, projecting outside the body to about the sixth week in the latter case and then sinking into the body leaving only a depression on the outer skin. Authentic cases are on record in which both ape and human child have been born with an external tail reminiscent of the earlier simian level. The appendages, and particularly the lower limbs, are also basically similar in ape and man, although fairly marked differences in specialisations have occurred which will be discussed in the following section.

The general structure of the head and face of man is similar to that of his anthropoid ancestor, although something of the prognathous jaw has been lost and the cranial capacity increased. The skull of the chimpanzee is frequently used as the standard of comparison in making anthropometric measurements on both primitive and modern man. According to Sontagg (14) the skull of the young chimpanzee resembles that of the ancient Piltdown man,

while that of the adult is strikingly like that of Neandertal man. The main difference here lies in the presence of a well-developed supra-orbital crest in the adult. This bony prominence over the brow of the adult ape and of Neandertal man served as the point of attachment for the massive muscles of the head and neck in these types. The young ape, like the human child, possesses a set of twenty milk teeth, and these are later replaced by thirty-two permanent teeth as in man. The dental formula for both ape and man is as follows: four incisors, two canines, four premolars, and six molars, in upper and lower jaw. The basic pattern of the several kinds of teeth is much the same, the reduction in size of the canines in man offering the most outstanding difference. The organs of the mouth and throat of ape and man are homologous, and are highly similar for the most part. The larynx and accessory vocal organs follow the same general arrangement, although the vocal cords are soft and some of the other vocal structures are more or less rudimentary in the apes.

The sense organs and nervous system of man represent another important heritage from the anthropoid level. The gradual recession of olfaction and the growing importance of vision and the other senses had reached an advanced stage long before the pro-human stock diverged. The correlative evolution of sense organs and nervous system is reflected in the elaboration of the neopallium with special centers for vision, audition, skin sensitivity, motor control, and associative processes. The brain of the great apes is so well developed along these lines that the localisation of cortical functions in man is determined largely by experimentation upon the ape brain. The general similarity between the brain of the ape and man may be seen by referring to Figure 7, and a detailed comparison of the two horizons will be found in the recent

work of Tilney (15). As Tilney has shown, the fissural pattern, lobation, and convolutional pattern of the human brain is essentially anthropoid. A striking increase in brain size, however, occurred in the pro-human or human stock, without a corresponding increase in bodily size. The frontal lobe also became disproportionately larger in size in the human line after the anthropoid level had been passed. The speech center also became definitely differentiated in the pro-human stock, since it is not found in the ape brain. While these changes were fraught with immense consequences, as the cultural evolution of man clearly shows, they represent relatively minor structural modifications of the basic anthropoid brain.

The anthropoid heritage of man is further revealed by the facts that have come to light regarding the constitution of the blood and susceptibility to diseases. Gulliver has shown that the red blood cells increase progressively in diameter from the lemurs to man, but the difference is slight between the great apes and man. The precipitin test, described in Chapter I, indicates also a much closer relationship between ape and man than between any other two of the main primate stocks. The recent delicate serological tests of Landsteiner and Miller show that ape and man are more closely related in blood constitution than is horse and donkey. As is well known, the latter types are so near of kin that they interbreed freely. These workers also find that the blood of the apes contains the same four groups of agglutinins which serve to distinguish the four main types of human blood, while that of the monkeys and lower primates does not. This means that the four types of blood, which were formerly regarded as distinctly human in character, had already become differentiated in the common ancestral strain and were passed on to pro-ape and pro-human stocks alike. It is also well known that the apes are especially susceptible to many

diseases usually regarded as being peculiar to man and this may be taken as further evidence of close relationship. The principle is well illustrated by the fact that induced syphilis takes a much more virulent form in the great apes than in the monkeys. Numerous instances of the same general sort may be found in the medical literature.

The biological basis of the sexual life of man can also be traced back to the anthropoid level or earlier. The primary sex organs of the human male and female are homologous with, and in general similar to the corresponding organs of the great apes. The secondary sex characters and the major lines of structural differentiation between the sexes are much alike in ape and man. For example, the female ape possesses only a single pair of mammary glands located in the thoracic region, and she is shorter in stature and has a smaller cranial capacity than the male. Sir Arthur Keith states that only in the anthropoids do we find the complex human type of placental organisation. The menstrual cycle appears in the female ape as in woman, and the period of gestation is approximately nine months in both cases. Sexual desire is no longer restricted to the rut phase of the sex cycle, as in the typical mammal, but is continuous in the female ape as in woman. The female is receptive to the courtship and mating of the male at any time except for a few days following parturition. Recent studies show clearly, moreover, that the great apes take the ventral position as does man in copulation, as well as the dorsal position of the typical mammal. As might be expected, the great apes had progressed one step forward from the promiscuous primitive horde life, since the latter involving a large band of females, is associated with seasonal sexual desire in the female. The great apes live in small groups which include only a few adult females at most along with the

young. This may be regarded as the beginnings of family life, this type of sexual restriction being taken over by primitive man, and later developed into the monogamous relationship after human culture had become fairly well advanced. As Miller (21) has pointed out, most anthropologists make the mistake of drawing a sharp distinction between the sexual or family life of ape and man, whereas it should be made between the anthropoids and some lower mammalian level in which sexual desire in the female is limited to the rutting season.

The social life of the anthropoid level appears to be dominated largely by the conditions of the family group, and this same factor has continued to be basic in the later cultural evolution of man. The young ape is capable of social independence by the end of eighteen months, according to Yerkes (29), and reaches sexual maturity at from eight to twelve years, depending somewhat on the species. This relatively long period of infancy and youth favors the gradual unfolding of the action-tendencies and behavior patterns as in human development. The sexual impulse arises long before sexual maturity is attained, and the sex play of childhood passes over into courtship and mating when the adolescent stage is reached. There are many other types of behavior that are markedly similar in ape and man, and most of these can be readily explained on the basis of structural likeness in the two types. The apes exhibit considerable skill in manual manipulation, and are able to make a direct and simple use of such rough tools as sticks, stones, and the like. They are not capable of very refined manipulation, however, because such ability depends upon structural changes that could only occur after the release of the hands completely from locomotor functions. Their range of vocal expression is also distinctly limited and there is no reason to believe that the existing apes can ever acquire language by any amount

of training. In temperament and emotional expression, as in general behavior, the apes tend to approach man much more closely than do any of the other primates or higher mammals.

Human Specialisation

It is evident from the foregoing account that man inherited his basic constitution and many of his specialisations directly from his anthropoid ancestor. The changes which were still to occur, after the divergence of the pro-human stem, in order to eventuate in the emergence of primitive man, must thus be considered as of a secondary nature. Moreover, these changes were such as might naturally be expected in connection with the adaptive radiation of the highly organized anthropoid stock from an arboreal to a terrestrial habitat. The descent from the trees thus deserves to be considered as the most important event in the evolution of the pro-human stem toward the human type. The modification of the lower limbs and feet along human lines, in connection with the development of erect bipedal locomotion, probably involved the most general structural specialisation. As this trend advanced, the upper limbs, no longer needed in locomotion, became adapted for skilled manipulative functions. The new and increased use of the foot and hand, both independently and in conjunction, led to the further elaboration of the neopallium, especially in the motor region. The perfecting of the language mechanism in connection with the increased demands for social coöperation in the new environment was also reflected in the brain by the evolution of the speech center. A general increase in brain capacity without a corresponding increase in bodily size also occurred, but this can hardly be regarded as distinctively human since it was shared by many of the con-

temporary mammals. Although these major changes are regarded as mere specialisations in terms of structural evolution, their final cultural potentialities must be measured by the difference between the life of the existing apes and that of modern man.

Although man shares the orthograde, or upright bodily posture with the gibbon and the anthropoid apes, the power of plantigrade locomotion, in which the sole of the foot makes contact with the ground belongs to him alone. The gibbons and the great apes all tend to walk forward on the toes when they attempt to assume an erect posture on the ground. The shift from the semi-erect bipedism of the ape to the erect bipedism of man brought about numerous structural modifications of the lower limbs which may be associated with the mechanical stresses of the latter type of locomotion. As Keith (12) and others have pointed out, lesser adaptations were also necessitated in various other parts of the body. The double curvature which is characteristic of the human spinal column, and the perfect poising of the head with the base of the skull almost at right angles to the backbone are among the more obvious changes that occurred. The lower limbs must have undergone a marked increase in length, since they are much longer in man than in the ape. This might be expected because of the fact that a high premium would be placed upon speedy locomotion under ground-dwelling conditions.

The human foot differs from that of the ape primarily in possessing a more prominent heel and a well-developed great toe which lies close against the other toes. As shown in Figure 9, the feet of all the great apes with the exception of the mountain gorilla, are strikingly similar to a hand, the weak great toe spreading outward in thumb-like fashion. This type of foot has obvious advantages in arboreal life but it is not well fitted for ter-

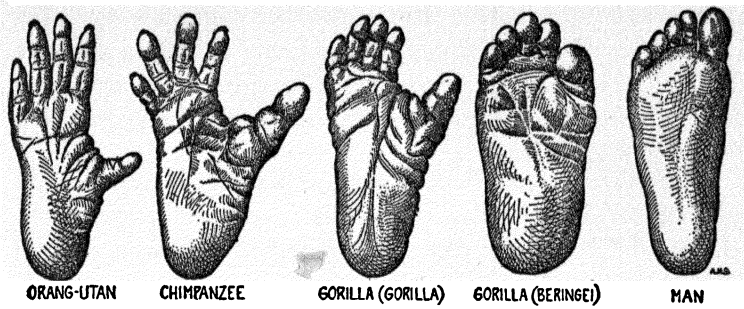


FIGURE 9. Feet of Adult or nearly Adult Anthropoid Apes and Man. Orang, after Schultz; Chimpanzee after Schlaginhaufen, 1911; First Gorilla after Hartmann, 1880; Second Gorilla (Mountain) after Akeley, 1923. (From Schultz, A. H., "Fetal Growth of Man and Other Primates." *Quarterly Review of Biology*, Vol. I, (1926), p. 498.)

restrial locomotion. The mountain gorilla gave up his arboreal life much later than man, and although now merely a semi-erect ground-dweller, his feet have become adapted structurally to some extent like those of man. In early foetal life, according to Straus (26), the human foot is similar in many respects to that of the monkey and ape. However, it passes through a stage not dissimilar to that of the mountain gorilla before attaining the distinctive human pattern. These and other lines of evidence suggest that the foot of the common ancestor of ape and man was more primitive and generalised than that of any existing type. After the divergence of the stems, the pro-ape foot became further specialised for arboreal life, while the pro-human foot gradually became adapted to terrestrial conditions. The foot of the mountain gorilla represents an intermediate type between the generalised anthropoid and the human pattern.

The evolution of the lower limbs and associated structures must have required considerable time. The passing of the forests occurred gradually, however, and the early pro-human stock might thus divide their time between

the forest and plain. Not until the trend toward erect bipedism became well established was anything like efficient locomotion on the ground possible. Whether the earlier pro-human types always attempted to walk erect or sometimes dropped down on all fours when on the ground is not known. That the latter may have been the case is suggested by the collection of facts recently reported by Hrdlička (18) relative to the behavior of children in learning to walk. He found that the human child often passes through a stage in which he gets about on all fours like a quadruped in developing the power to walk erect. The report covers almost four hundred cases, very largely of the white race, but including a few Indian, Eskimo, Negro, and other children. In some cases this mode of locomotion persists long after the child has learned to walk upright, the one method being used at one time and the other at another time. Usually, however, it makes its appearance about the seventh month and continues for four or five months, at which time the child begins to walk normally. As Gregory suggests, this behavior may be reminiscent of a primitive quadrupedal ground phase following the descent from the trees. Perhaps both quadrupedal and bipedal locomotion were employed under different circumstances by the pro-human stock at first. Nevertheless, in time the upright posture and gait became predominant and normal.

The evolution of erect bipedism carried with it a gradual release from locomotor functions of the upper limbs and led to their modification along lines favorable to manual dexterity. The common ancestor of ape and man must have had relatively long arms as a result of ages of brachiation but there is no need to suppose that they were as long as those of existing apes. Brachiation continued in the pro-ape stock after the divergence of the pro-human stem, and the excessively long arm of the ape doubtless

represents further specialisation in an arboreal habitat. This is clearly shown by the fact that the difference in length of arm as between ape and man is less marked in foetal life. It is well known also that the extremely long arms of the gibbon is a post-embryonic development indicating the relatively late acquisition of this character. In all probability, the upper limbs did not increase in length much if at all in the pro-human stock after the divergence, while the lower limbs did show a marked increase in length. This accounts for the fact that the arms of man are somewhat shorter than his legs although just the opposite is true of all the existing great apes. The hands also specialised along different lines after the divergence of the two stems. The hand of the ape increased in length and the thumb decreased in size, while the hand of man retained something of the primitive shortness, and strength of thumb of the ancestral type. The hand of the mountain gorilla is much more like that of man than is true of the arboreal apes, as may be seen by referring to Figure 10. Although the thumb is opposable in all the apes, it has become so reduced in size in the arboreal types as to be of relatively small use in grasping objects. Doubtless the recession of the thumb, which is a natural result of long-continued brachiation, had not gone far in the pro-human stock at the time of divergence. The human thumb is well developed in foetal life, and according to Schultz (25), appears to undergo an important post-natal acceleration in growth. The distinctly human thumb was apparently acquired late.

As is well known, neither ape nor man possesses special organs of speech in the strict sense. Both vocalisation and gesture involve the use of phylogenetically old mechanisms whose primary functions have no necessary connection with language of any sort. Although language thus rests upon a secondary morphological basis, the ex-

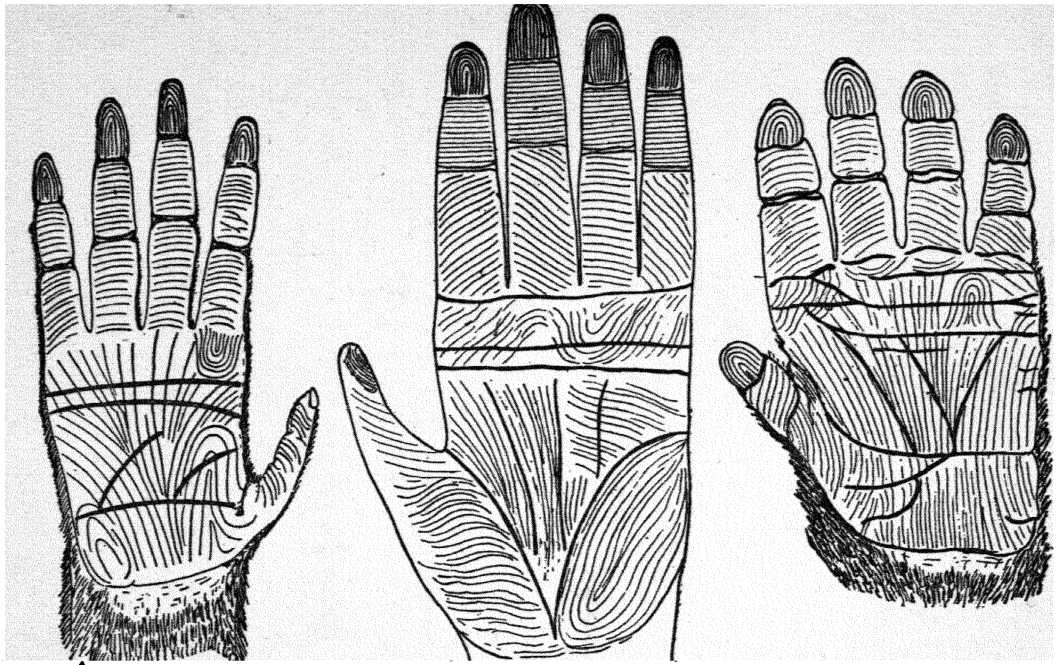


FIGURE 10. HANDS OF ANTHROPOID APES

A, Orang-Utan; B, Chimpanzee; C, Gorilla, showing the flexure grooves (thick lines) and papillary ridges (fine lines). (From Sonntag, C. F., "The Morphology and Evolution of the Apes and Man." John Bale Sons & Danielsson Ltd., London.)

tensive use of vocalisation and gesture in the pro-human stock eventually led to structural changes in the mechanisms employed. The muscles of the larynx, all of which are found in the ape, became much more highly specialised in the human line. The gradual recession of prognathism in the pro-human stock as well as an increased mobility of the tongue, and other minor changes in the mouth and throat regions, led in time to the more efficient vocal powers of man. As we shall see, the conditions of terrestrial life placed a high premium upon the use of vocal and gestural signals. We are not surprised, therefore, to find that a special cortical center for speech evolved only in the human line. It is significant in this connection that all attempts to develop language capacity in the apes have ended in failure. As Yerkes (29) believes, most if not all of the natural cries of the great apes are merely emotional expressions, as is also true of the mammals in general. In a few cases, certain of the apes have been able, after extensive training, to associate the sound of a human word with a definite object or act. However, the dog (28) probably possesses an even greater ability of this sort as may also be true of certain of the birds (16). The wide use of vocal and gestural language by man marks him off, more than any other one thing, from the apes and from all other animals. Although the structural changes involved in the evolution of language represent minor adaptations, these are possessed by man alone. While the apes and other animals may be trained to learn a few auditory signals, when directly associated with objects or acts, they must be regarded as forever incapable of the complex symbolic process which we ordinarily term human language.

It is a commonly observed but striking fact that the nervous system tends to keep pace with the evolution of sensory-motor mechanisms in the organism. This is so

true that the nervous system, and especially the brain, may be used as a rough index of sensory-motor evolution within a given group such as the primates. As we have already noted, the brain in the pro-human stock increased greatly in size, while the weight of the body remained approximately the same. This increase is indicated in the diagrams of Figure 7, which are drawn to scale, and by the known facts regarding the brain weight and cranial capacity of ape and man. The brain of the great apes ranges in weight from 300 to 500 grams, while the body weight is much greater than that of man. The average human brain weight is something like 1400 grams, being above 1000 grams in the Australian pygmies, and reaching well over 2000 grams in the more advanced races. The brain of Cromwell, for example, weighed 2231 grams, while that of Byron ran to 2294 grams. As Sir Arthur Keith (12) has noted, the brain of ape and man at birth weighs 200 to 300 grams and 300 to 500 grams respectively, which shows that the enlarged adult human brain is a postnatal development, and hence a relatively late evolutionary character. The three outstanding human characteristics, as discussed above—erect bipedism, manual dexterity, and language—would seem to call for a further elaboration of the brain in the pro-human stock to take care of these several functions. The active life of the plains, involving skilled movements of both upper and lower limbs led, through the process of natural selection, to the further evolution of the sensory and motor centers of the neopallium. The pressing need for language brought about, in the same manner, the differentiation of the speech center. These several changes, together with the unusual development of the frontal lobe, which is commonly regarded as being basic to the higher associative processes, make up the distinctive characteristics of the human brain.

The question is sometimes raised as to which of these leading specialisations—postural, manual, cortical, or lingual—should be considered the primary factor in the emergence of the human type. In general, the question sounds a bit pedantic and the answer given in any case is likely to reflect the bias of the special field of interest of the person who offers it. If the facts were known they would doubtless show that evolution began along all of these lines when m .ı descended from the trees and has since continued as a series of interpenetrated events from all these sources. It might be argued that the hand could not become adapted for refined manipulation until an erect posture released it from accessory locomotor functions. Or, we might conclude, as Elliot Smith has done, that neither erect posture nor manual dexterity could come about until the brain had undergone the necessary elaborations to care for these new functions. Logical deductions of this sort are quite beside the point, however, when we take into account the fact that each of these specialisations must have arisen gradually. As we shall see, primitive man himself did not stand perfectly erect and may not have possessed the manual dexterity of modern man. He possessed a cortical speech center but we cannot be certain that it had come to full perfection as yet, and there is good reason to believe that the frontal lobe was less well developed then than later. It seems likely, therefore, that the four characters evolved more or less simultaneously, although this need not mean that each showed the same rate of progress from stage to stage. When taken together they represent the general evolutionary adjustment of the highly organised arboreal anthropoid to a terrestrial habitat.

The search for the specific factors which may have operated in the evolution of the more distinctively human specialisations has not been very successful as yet. Sir

Arthur Keith (20) and others have stressed the probable influence of glandular factors in this connection. It is well known that the endocrine conditions are of considerable importance in determining normal mammalian development, including that of man. The pituitary and pineal glands, lying at the base of the brain, and the thyroid gland located in the neck region, are chiefly involved. An increase of the pituitary secretion above the normal supply tends to accelerate bone growth and may result in acromegaly, or even in gigantism in extreme cases, while a sub-normal secretion leads to the formation of long slender bones. The pineal secretion seems to hold in normal abeyance the development of stature and of the sex organs until the time of puberty. A superabundance of pineal secretion tends to bring about a premature growth in stature and a precocious development of both primary and secondary sex characteristics. Hyperthyrodism involves an abnormal increase in the rate of metabolism and brings about a characteristic pattern of behavioral disturbances. These glandular factors are closely interrelated and normal development depends upon the maintenance of a proper endocrine balance. There is good reason to believe that many of these conditions are hereditary, which suggests that glandular factors may have played an important rôle in evolution. However, since these glands are common to the vertebrate group as a whole, there seems to be no reason for regarding them as especially related to the evolution of distinctly human characteristics.

The most that can be said at present is that the emergence of man was a natural consequence of the trends that became established in the pro-human stock following the descent from the trees. The human specialisations which have resulted are relatively slight on the strictly structural side, when compared with those occurring in connection with changes of habitat in other organisms. The

difference between a fish and a mammal, for example, is obviously much greater than that between ape and man on the structural side. But, as we have seen, the trend which eventually led to the mammal was set up by the adaptive radiation of the fish from an aquatic to a terrestrial environment. There seems to be no need, therefore, to search for unique causes in order to account for the emergence of man. In the end the human specialisations, however slight, proved to be of critical importance in the development of a complex social life, and they must be valued accordingly by the student of human evolution.

Beginnings of Human Culture

In the previous section we have attempted to bring into relief the structural characters which most clearly distinguish man from his anthropoid forbears. As we have seen, these are not only few in number but each represents a much less marked degree of difference than is commonly supposed. This means that man as a biological organism offers no particular problem to the evolutionist. His bodily organisation is a direct heritage from the anthropoid level except for a few minor modifications which became more or less inevitable upon the descent from the trees. These structural specialisations of man may be as readily explained on general evolutionary principles as the divergent specialisations of the chimpanzee and gorilla. In spite of this fact, no one can honestly deny that man as we know him is a vastly different sort of being from his ape cousins. The truth seems to be, as we have hinted all along, that this difference is mainly cultural rather than biological in the narrow structural sense. As a matter of fact, the central problem of human evolution, from the anthropoid level onward, is to account for the beginnings of culture. It does not, at first glance, seem rea-

sonable that a being so essentially anthropoid could have built up a primitive society, to say nothing of a complex civilisation. The solution of this difficulty lies in shifting the point of emphasis from human specialisations themselves to the immense cultural possibilities which these possessed. When this is done it becomes clear that these biological factors are important primarily because they set up progressive trends of a broadly social sort which eventually led to a cultural evolution.

We may approach the problem from this new angle by inquiring into the cultural potentialities of certain of the human specialisations enumerated above. The factors of manual dexterity and of language capacity appear to be most directly connected with the human culture complex, and the present discussion will be limited accordingly. In making an analysis of this sort the postural and cortical specialisations characteristic of man, as well as the basic anthropoid complex as a whole, must naturally be taken for granted. Our present aim is to establish a nexus between the pro-human anthropoid life and primitive human culture, and the two factors mentioned have been chosen because they seem to offer the most natural lines of approach. The main problem here is to show how these factors, operating under the natural conditions of life on the plains, set up trends which virtually created the social and industrial order of mankind. The present discussion will be restricted to the problem of culture origins, and the later course of events will be treated in the chapters that follow.

Before passing to the discussion of manual dexterity and language as cultural agencies, the point should be emphasized that at least one element of culture was taken over by primitive man directly from the anthropoid level. As already noted, the anthropoid family group is small, consisting of an adult male, one or at most a very few adult

females, and the young of various ages. The family life carries with it also certain elements of maternal care and paternal protection, as might be expected, in view of the relatively long period of anthropoid infancy and childhood. The family thus represents a distinctive type of social relationship and, in fact, may be considered the basic cultural pattern of anthropoid life. There is no reason to suppose that monogamy arose until long after man had arrived on the scene, although we do not know definitely when this change occurred. The family life of primitive man, therefore, may be regarded as essentially anthropoid. In this case, then, no special evolution was necessary since early man merely continued in the steps of his anthropoid forbears. This fact is important because of the emphasis usually placed upon the high value of the family group in the cultural life of mankind. The value itself is not to be denied, but the evidence is clearly against the notion that the small family group is a distinctively human institution.

The évolution of manual dexterity resulted naturally from the conditions of life upon the plains. The high table lands of central Asia at this period consisted largely of open country, with only sporadic forests, the vast plains being covered with grasses and wild grains. The climate was temperate rather than tropical and the trend was toward a gradually increasing coolness with the passing of time. The problem of a sufficient food supply and also that of protection and shelter became immediate and pressing. It was necessary, of course, for the pro-human stock to shift from a frugivorous to an omnivorous diet in which game and fish were probably important elements. Game was plentiful but most of the suitable animals of the plains were fleet of foot and easily able to out-distance their pro-human pursuers, even after erect bipedism had become well established. There was also strong compe-

tition for food of this type from the carnivorous horde that roamed the plains. No longer shielded by the dense forests, the pro-human anthropoids must devise some new means of protection or become themselves the prey of these carnivorous enemies. The bare hands of the anthropoid were of small use in combat as against the tooth and claw of these ancient inhabitants of the land. It is clear, therefore, that the demands for food and protection forced the pro-human stock to make use of instruments wielded by the hand or to perish from the earth. The hand was an excellent grasping organ, even at that stage, and the ability to coördinate hand and eye in behavior had been well developed in arboreal life. As erect bipedism released the hands from locomotor functions, it was only natural that good use should be made of sticks and stones under the circumstances in the effort to secure food and to protect themselves. No special explanation is necessary, therefore, to account for the rude beginnings of tool-using among these ancestors of mankind.

Most of the pro-human stock were doubtless swept away under the conditions of rigorous selection which resulted. In the end only those that turned manual dexterity to account in a cultural way were able to survive. The continued use of such rough tools as might be found in nature naturally led in time to the construction of others better adapted to serve the purposes associated with manual activities. These primitive constructions probably involved no more at first than relatively slight but crucial modifications of such natural objects as sticks and stones. The branch of a tree broken off so as to have a jagged sharp point, for example, would be easily produced and could be used as a rude spear. Breaking stones so as to give them the proper shape and weight for throwing would also represent a simple type of tool-construction that must have arisen early. The existing apes are able to construct, with

their clumsy hands, rude nests among the boughs, and even to put together such natural objects as hollow bamboo stems to be used as tools. The transition from tool-using to simple tool-construction thus appears to be a natural step at the anthropoid level of organisation. Among the pro-human stock, construction of instruments for securing food and for use in combat eventually advanced to the point where the technique of construction itself became a matter of some moment. This would mean the setting up of a cultural trend in which the method involved would be passed on from generation to generation as a social heritage. Nor would language be essential at this early stage, since imitation and non-verbal tuition would offer adequate means of transmission for the simpler types of constructive skill.

The protection of the family group also offered a problem of pressing importance under ground-dwelling conditions, and here again manual constructiveness could be turned to good account. It was no longer possible to nest at night in the trees or to leave the family protected in the forest while going in search of food. Few caves or other kinds of natural shelter were to be found in the open country and hence it became necessary to build shelters or fall a prey to the night-prowling carnivorous animals on every hand. When natural fortresses were not available, simple stone defenses might be constructed with comparative ease. These early hiding places were doubtless small and crudely built, but they at least afforded a place where the pro-human family could huddle together in safety at night. Here also the young, or perhaps the mother and young, might be left by day when the search for food became necessary. As manual dexterity along this line increased and better modes of constructing shelters were developed, the methods involved became a part of the cultural heritage of the group. The need for clothing

did not arise until much later since the pro-human anthropoid and, perhaps even earlier primitive man, was well covered with hair. Nevertheless, the basic human arts, associated with instruments for securing food, weapons for personal defense, and shelters for family life must have arisen comparatively early in the pro-human line. A rude practical culture was necessary to survival on the plains and the cultural patterns then established were carried forward with modifications into the still simple social order of primitive man.

In the broad sense, language may be regarded as a system of signs by means of which communication between organisms is brought about. The signs or signals employed may be either gestural or vocal, these being perceived by the eye in the one case and by the ear in the other. Any part of the body may be used in making gestures, but the hands and arms are the members most usually employed. Although gesture language is somewhat rudimentary it can be effective at distances beyond the sound of the voice. It may also be employed without attracting unduly the attention of others in the vicinity. The language of modern man is primarily vocal and articulate, such systems of gesture as he now uses having been derived, according to Vendreys (27), from older vocal systems. It is generally agreed, however, that gesture language is probably as old in point of origin as vocal language. Little or nothing can be determined concerning the origin of either from the historical approach because comparative philology does not carry us back further than a few thousand years at the most. By this time articulate language had long since become exceedingly complex. As is well known, primitive man possessed a cortical language center at least a million years ago. This can only mean that the evolution of the language function had occurred long before this time, bringing about this basic structural modifi-

cation. As we have already noted, the vocal mechanisms essential to speech form a part of the natural equipment of the anthropoid and have been modified only in detail in man. While there is no direct evidence, therefore, to show just when articulate language arose, the indirect evidence favors the view that the beginnings of language extend far back to the pro-human level.

Language is essentially a social instrument and it must have had its origin under the pressure of an imperative need for social intercourse. The conditions of life on the plains were such as to bring social factors into the foreground, in sharp contrast to the arboreal existence that had gone before. In the latter case, protection and shelter had been largely matters of individual concern, since each anthropoid might rush to a tree in case of emergency. The new environment, however, called for social coöperation for purposes of mutual aid and protection. Even when the increase in manual dexterity had made the use of rough tools possible, the pro-human anthropoid was still hardly a match, single-handed, for his strong and fierce carnivorous adversaries. In order to become genuinely effective, the use of instruments and weapons required the additional aid of group strategy. As we have seen, the small family group represented the primary if not the only important pattern of social life among the anthropoids. This was conditioned largely by sexual factors and was obviously not well suited to form the basis of groups for purposes of forage and protection. The situation demanded a new and larger grouping of adults, on a non-sexual basis, to form bands capable of extensive exploration and of adequate community defense. These large bands may have been chiefly males, and if so this grouping might well mark the beginning of the division of labor between the foraging and fighting male and the female and family left behind in some secluded

shelter which had been constructed. In any case, these larger groups in order to coöperate effectively must be able to give and understand a few common signals. The capacity to make use of signals, whether gestural or vocal, would thus come to possess a definite survival value under the new conditions. A rigorous selective process at this stage doubtless occurred which led to the establishment of a trend toward the effective use of language.

Nothing of a direct nature is known regarding the concrete circumstances under which the pro-human anthropoid began making use of signals in the language sense. It seems altogether likely, however, that the first rude language was merely an extension of the natural emotional cries and gestures to larger group situations. A genuine language function might well be served by so simple an act as pointing to an enemy and uttering a cry of horror, and the biological consequence might also become extremely important. The signal, in such a case, would possess both gestural and vocal elements but in time these might easily become separated into more or less definite systems. Either the vocal or the gestural element could be omitted or suppressed under different circumstances. Mere pointing, for example, without the usual outcry would be advantageous when it was desirable not to reveal the location of the group to the enemy. Vocal expression alone, on the other hand, would be of special use at night and at other times when gestures could not be observed by the group. Simple signalling probably lies within the limits of anthropoid capacity, and the imperative need for coöperation within the pro-human group doubtless brought this ability into the foreground. As the use of signals advanced in extent and definiteness, the gestures and vocal expressions commonly employed within the group were transmitted as a cumulative tradition from generation to generation. Many of the enlargements

and refinements introduced from this point onward would represent cultural rather than biological modifications. In time the simple biological beginnings of language became so overlaid with the more strictly cultural factors that the earliest known human language seems almost wholly unrelated to anthropoid emotional expression. The complexities and refinements of human language reflect the influence of man's inventive genius in developing this basic instrument of social coöperation in harmony with his increasing cultural needs.

Most traditional theories of the origin of language ignore very largely the evolutionary background of this capacity as suggested above. In fact, the usual assumption seems to be that man took on language in some more or less accidental manner after his evolution was complete. It would be much nearer the truth to say that the prohuman anthropoid became man only when his capacity for language had evolved up to a certain level. During the latter part of the 18th century the opinion was prevalent that primitive man invented language somewhat after the manner of the social contract arrangement. Such a notion is clearly untenable, since it presupposes the very social conditions which could have been gradually created only by an evolving language. Nor is there any good reason to suppose that the pre-language anthropoid was possessed of a stock of ideas which were in pressing need of some means of expression. It was only when this being began to walk erect, make constructive use of his hands, and employ signals in the larger social situations of the plains that he was enabled to think along human lines. It was the pressure of the new environment, and the consequent operation of natural selection, that brought about the rude beginnings of language. It was the social tradition that language itself created that led to the refinements distinctive of the historical languages of mankind.

Some of the more widely known theories of the origin of language should perhaps be mentioned in passing, although most of them have long since been discarded. The Onomatopoeic, or "bow-wow" theory of Herder supposed that the first words of primitive man were derived by mimicry or imitation from the characteristic sound emitted by the object or being. The bleating of the sheep, for example, suggests the term, bleating, and the latter comes to stand for the animal. Many critics have pointed out that none of the historical languages contain more than a very few words which show this sort of correspondence with natural sounds. The Interjectional, or "pooh-pooh" theory, stresses the emotional or exclamatory repertory of primitive man as the source of language. At best this theory would account for relatively few words. Moreover, no explanation is offered as to how the spontaneous ejaculation might come to possess objective and social significance. The eminent comparative philologist, Max Müller, stoutly opposed both of these views, pointing out that words so derived are usually sterile in that they seldom give rise to cognate forms. His own conception of the origin of language, which he later abandoned, has been nick-named the "ding-dong" theory. Every natural object, so Müller argued, has its own peculiar ring when struck, and primitive man possessed an instinctive faculty whereby such impressions from without were immediately vocalised from within. This mystic harmony between sound and sense, and the instinct that lay back of it, belonged only to the age of primitive man which he regarded as the "springtime of speech," when human language, once for all, came into being. Each of the three theories mentioned above assumed that the single word was the unit of vocal language in so far as the matter of origins is concerned. Moreover, each took it for granted that language arose in the individual instead of within the social group.

These early theorists also made the mistake of supposing that the evolution of language in the race was closely analagous to the development of language in the human child.

The social factor in language is recognised in the sympathy, or "yo-he-ho" theory of Noiré and the "sing-song" theory of Jespersen, although it is made more or less accidental in both cases. Noiré supposes that the first words arose from the fixation of such natural sounds as are emitted in concerted group effort, the word "heave" being a good example of this. A word so derived would possess a common meaning for the group since it connoted the same act to each one of the group. This theory makes concerted group action appear prior to language, whereas it was doubtless a rude language of some sort which made such activity possible. Jesperson denies outright that the primary function of language at the beginning was the practical need of communication, and stresses the play motive throughout. Primitive man was much given to vocal play as illustrated in more or less meaningless babblings and improvised songs, and only gradually did these vocalisations come to acquire definite meanings. Language was born, so he thinks, in the courting days of mankind, when man had little to do except to sing love ballads around the nightly campfire. The practical motive is thus completely ignored. In fact, both of these theories make the origin of language a happy accident which occurred after the structural evolution of man had been attained.

Wundt regarded language as the natural outgrowth of the cries and expressive movements of primitive man and his animal forbears. Communication by this means arose primarily through the arousal of mimetic and imitational behavior in the observer. The movements of articulation are thus of first importance, while the resulting sound is

a mere by-product, until later, when it comes to take the place of vocal gesture. The transition from the emotional to the more strictly communicative level of speech, which is characteristic of man, is not explicitly linked up by Wundt to the demands of group life which arose under ground-dwelling conditions. Sir Richard Paget (22) has recently enunciated a gestural theory of speech. He supposes that early man first made use of gestures mimetic of the behavior concerning which he wished to converse. Because of the common tendency to make similar movements with the tongue, lips, and other organs of articulation while making bodily gestures, the former came to be pantomimic replicas of the latter. Thus the Aryan root "gar" which means to devour greedily is spoken by making a swallowing movement, and the root "ska" which means to cut involves a cutting movement of the tongue. One of the chief criticisms that may be urged against this theory is that such relationships, even if true, can be traced no further back than a few thousand years, and can have little bearing upon the origin of language.

In general, most of the above theories seem to be dealing not so much with the origin of language itself as with modes of language elaboration after the human level had been reached. A more complete statement of the several theories as well as specific criticisms of each will be found in the volumes covering this topic listed in the bibliography. The discussion of De Laguna (17) on the origin of language is especially recommended since she recognises to a greater extent than other writers the evolutionary background involved. De Laguna emphasizes the likelihood that the first elements of vocal speech were not single, distinct words in the modern sense, but sounds carrying the complex meaning of a full sentence. A good example of this usage is to be found in the mot-phrase, or sentence-word, common to the speech of children, in which

the associated meaning is implicit in the environmental context. This notion is in agreement with the observation of Jespersen that the evolution of a language shows a progressive tendency from inseparable, irregular conglomerations of sound to more regular and easily combinable short elements such as words. Whatever may be the facts regarding these and similar details, we may be certain that language arose naturally out of the practical need for social coöperation under the conditions of life on the plains.

The various lines of facts relating to the beginnings of culture as set forth in this section seem to show clearly enough that no special factors need be brought in to account for the social life of primitive man. One important element of culture—the small family group life—was brought over directly from the anthropoid level. The evolution of erect bipedism which freed the hands from locomotor functions led inevitably to a marked increase in manual dexterity under the pressure of the new environmental conditions. This increase gave rise in time to the cultural trend associated with the construction of tools and shelters which may be regarded as continuous with the corresponding culture complexes of primitive man. The need for a new type of social coöperation in addition to that represented in the small family group led to the evolution of the necessary structural modifications in the vocal organs and brain. In the end, language itself became a cultural factor of such importance as to almost completely dominate the social life of primitive and modern man.

Chapter IV

TRACES OF EARLY MAN

We may now turn our attention to the task of interpreting the life and times of prehistoric man in so far as this is possible. This interpretation must rest primarily upon the skeletal and cultural remains of primitive man as these occur in orderly sequence in the paleontological record. The earlier stages of this phase of human evolution will be discussed in the present chapter, while the later stages leading to the beginnings of the historical period will be reserved for the following chapter. The first clear traces of human existence so far discovered belong to the Eolithic, or Dawn Stone culture of the late Pliocene epoch. On the basis of this direct evidence, the human record can be extended backward approximately one and one-half million years, according to the present reckoning of geologic time. This means, of course, that the paleontological record of primitive man stops far short of the point at which human status was actually attained by the evolving pro-human stock. As might be expected, several developments of a most important nature occurred during the period covered by this gap in the human record as at present deciphered. In general, these relate to the time and place of man's emergence, the gradual dispersion of mankind over the earth, and the diversification of the early human stock into a number of generic types. Certain problems associated with these prior events will be discussed in the present section before passing to the survey of later human developments as recorded in the rocks.

It is impossible as yet to set the time at which the pro-human stock attained the grade of primitive manhood with any degree of exactitude. As we have seen, the definite human trend probably began as early as Middle Miocene times, or something like sixteen million years ago, when man's ancestors finally separated from the arboreal anthropoids. The pressure of the physical and biotic environment must have been extremely severe during the period immediately following the descent from the trees. For, as we have shown, each of the human specialisations—erect bipedism, brain elaboration, manual dexterity, and language capacity—was directly related to the survival of the type in the new habitat. In view of the rigorous selective process which thus ensued, we are warranted in supposing that the gross changes required in making a fairly adequate adjustment to terrestrial conditions occurred rather speedily. Nevertheless, a long period of gradual evolution was doubtless necessary to bring these structural and cultural trends up to the level of perfection at which they appeared in primitive man. It seems likely, therefore, that by far the larger part of this period of sixteen million years was consumed in evolutionary changes preparatory to the appearance of primeval man. Some light is thrown on this general problem by the stage of development represented in the earliest skeletal and cultural remains of man, which date back approximately a million and a half years. At this time, the human specialisations had long since become highly perfected and the basic cultural traits had progressed far beyond what is usually regarded as the lowest human level. These several lines of evidence, when taken together, seem to support the prevailing opinion that human status was attained as early as Middle Pliocene times, or something like four million years ago. It should be borne in mind, however, that the transition from human-like anthropoids to an-

thropoid-like humans represented merely one of the many steps in pro-human evolution. There is no real justification, therefore, for making a sharper distinction at this point than elsewhere in this long series of events.

Central Asia is most generally regarded as the cradle of the race, although there are those who favor Europe, North Africa, or some other Old World locality. The weight of evidence from many sources seems to render the Asiatic theory at least highly probable. The main facts relating to mammalian and primate evolution as presented in the foregoing chapters all tend to support this theory. In the first place, the plants and animals which were later domesticated by man reached their highest evolutionary status upon the plains and plateaus of central Asia—so broad in extent and so richly varied in life conditions. The higher primates evolved in this same region, and here also the pro-human stock remained when the pro-ape types migrated southward with the retreating forests. Moreover, there is no good reason to suppose that the pro-human stock left this great region stretching to the north of the Himalayas, during the long period of structural and cultural evolution which culminated in primitive man. The fact that Asia is centrally located with respect to all other land masses, and at this time offered natural and direct migratory routes over which man might pass to other lands constitutes another favorable argument. Finally, the oldest civilisations of which we have any account were Asiatic, and such cultural developments might well be expected to make their first appearance somewhere near the focal point of human life.

The evidence offered in support of the European and African theories seems to be slight and unconvincing. Europe is relatively small and isolated, and neither the series of fossil primates found there nor the general environmental conditions point to it as the birthplace of man.

While human remains have been discovered in greater abundance in Europe than elsewhere, most of these belong to relatively recent times. It should also be remembered that this continent has been much more thoroughly explored than either Asia or Africa. Darwin was inclined to regard Africa as the cradle of the race because it has long been the home of the chimpanzee and gorilla. The chief protagonist of the African theory at the present time is G. Elliot Smith. He stresses the fact that several of the more important types of fossil apes have been found in Egypt. However, it should be noted that all these belong to the pro-anthropoid level, or earlier, and not to the full anthropoid level from which the pro-human stem diverged. The evolution of the pro-anthropoids in Egypt is generally recognised, even by those who hold the Asiatic theory. But Dryopithecus of the Siwalik Hills of India is certainly a much later type than Propliopithecus of the Fayûm region of Egypt. The primates were migrating northward at this time and there is good reason to think that the full anthropoid level was not attained until the plateaus of central Asia had been reached. The fact that certain very primitive peoples, such as the negroid pygmies, now live in Africa, is sometimes interpreted to mean that this was the original home of the earliest and lowest human type. As has often been pointed out, however, this fact would seem to indicate just the opposite conclusion, since the descendants of the earliest migrants should be found to-day farthest removed from the center of origin.

The human stock was derived from a single pro-human species, according to the best opinion, and hence may be regarded as monophyletic. Very early, however, primitive man began to migrate from the homeland of central Asia and eventually the human stock split into a number of generic types. Numerous waves of migration must

have occurred during the long period that elapsed between the coming of man and the beginning of the paleontological record as we now know it. The motives lying back of these movements naturally differed from time to time, but they were doubtless intimately related to such factors as over-population, food shortage, scarcity of materials for implements and shelters, and the like. Curiosity, wander-lust, disputes, and wars may also have been important influences in the gradual spread of the human family to regions farther and farther removed from the ancestral home. These successive migrations were highly selective in character since, under primitive conditions, large groups became so widely separated as to prevent any possible mating between them. Migration often meant more or less radical changes in environment and these led in time to certain differences in bodily features and also in cultural traits. As a result of this general dispersion, the human stock, or the Hominidae, gradually became diversified into distinct generic types, occupying different regions of the earth. None of these generic types, except Homo sapiens, survived to the historic period, but their general characteristics are known to us from fossil remains which have been found.

The main generic strains had become isolated long before the opening of the Pleistocene epoch, or age of man. It seems likely that the human stock had spread over Eurasia and northern Africa at least a million years before this time. This is suggested by the fact that the Lower Pleistocene fossils possess such divergent features that they must be placed in different generic groups. Such well-marked diversifications as then existed could only have been brought about through ages of group isolation. Nor do we know how many other generic types came into being only to be swept away without leaving any discoverable traces. As may be seen by referring to Figure 11,

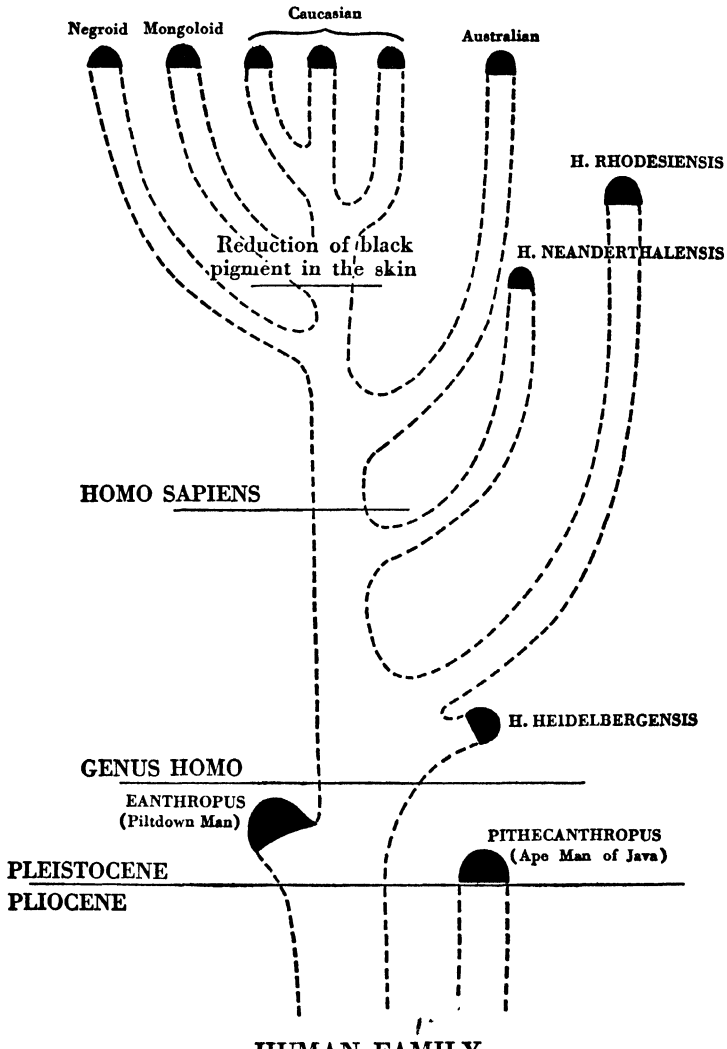


FIGURE 11. A tentative scheme of the genera, species, and races of the human family. The Caucasian or Caucasoid stock includes the Mediterranean, Nordic and Alpine races in order. (Modified from Smith, G. Elliot, "Essays on the Evolution of Man." Oxford University Press, 1927. Figure 1.)

two distinct genera aside from the genus Homo, are represented in the fossil record. These are Eoanthropus, or the man of Piltdown, England, and Pithecanthropus, or the ape-man of Java. The man of Heidleberg, the man of Rhodesia in South Africa, and Neandertal, or Mousterian man, whose remains have been found in various parts of Eurasia, are all usually regarded as merely distinct species of the genus Homo. The stock which later gave rise to Homo sapiens, or modern man, apparently remained in Asia near the center of dispersion until Upper Pleistocene times. The main facts relating to the several extinct genera and species of the human family which have been discovered will be given in the present chapter. The later development of the species, Homo sapiens, from which all the existing races of mankind are derived will be treated in the following chapter. Before beginning this survey of the skeletal and cultural remains of primitive man it will be of value to discuss briefly the nature of the traces of early man which comprise the record of this stage of human evolution.

The Human Record

Our knowledge of the life and times of prehistoric man is based upon the skeletal and cultural remains which have been preserved in deposits of one sort or another and eventually discovered. The fossils and artifacts representing the more remote past are relatively rare and often more or less fragmentary. This may be explained in part by the fact that the regions of the earth which were occupied by early man have been devastated since by several major glaciations. In view of these and numerous other unfavorable circumstances it is somewhat surprising to find that the human record can be extended backward to a time well over a million years ago. As might be expected,

both types of human remains become more plentiful and also less fragmentary as we approach the more immediate past. In order to understand better this long record of primitive man, it will be desirable to discuss briefly some of the methods employed by the paleontologist and archeologist in dealing with this general problem.

The approximate age of human remains can be settled readily enough, as a rule, provided it is clearly evident that the deposit has not been disturbed in any way. The stratigraphic method is now universally employed, hence it is necessary merely to determine the geological position of the stratum in which the materials may be found imbedded. The possibility must be recognised, however, that the find may have been shifted to its present position by the action of such natural forces as water, wind, glacial movements, and the like, or by the hand of man. A recent fossil, for example, might be easily washed into an older geological formation by the force of a stream that had previously cut its way through the overlying strata. Moreover, after the custom of intrusive burial arose among mankind the position of the fossil would be determined in part by the depth of burial employed at the time. The matter of dating human remains is often complicated by the fact that they are removed from their natural resting place by workmen and others who are unable to determine the precise stratigraphic position later when the finds have come to the attention of the scientist. In addition to the geologic formation of the stratum, the presence, along with the specimen, of the skeletal remains of extinct animals of known distribution and age may prove highly valuable in properly dating human skeletal and cultural discoveries.

As might be expected, only a few of the early generic types are represented in the fossil record, and in most cases the specimens discovered are mere fragments. For untold ages the human dead were doubtless devoured by the

wild animals of the plains and their bones scattered about to become disintegrated by the action of the elements. There was small chance for a natural burial to occur in a manner which, by an exclusion of air and moisture, would be favorable to long-continued preservation. Not until we come upon the sheltered recesses of the cave-man of Mousterian times do we find an abundance of well preserved fossil material. The earlier skeletal remains of man include, for the most part, merely the jaw or skull, with perhaps one or more of the long bones of the lower limbs. These parts together with the teeth comprise the hardest and most durable portions of the anatomy and hence were least likely to be destroyed by the ravages of time. Such bones are usually found more or less heavily mineralised by the infiltration of certain of the compounds of iron, silica, magnesium, and the like. Often some parts are broken or perhaps entirely missing and the expert knowledge of the comparative anatomist is necessary to reconstruct the skeletal framework. Several important fossil types, more completely reconstructed so as to show their natural features, are illustrated in the Frontispiece.

The fossil remains of primitive man represent a variety of collateral stems and specific types and hence cannot be arranged in a linear series leading directly to man. Nevertheless, as we shall see, certain trends indicating the gradual recession of the more ape-like features of early man appear to run through the series as a whole with fair consistency. Our interest at this point is to call attention to some of the common anthropometric indices which have been found useful in showing trends of this sort. This will enable us to understand that the reconstruction of fossil fragments is a quantitative science and not merely a matter of shrewd guesswork as many are likely to suppose. The general skeletal characteristics of the body can be determined by the comparative anatomist

from so little as the skull and one or more of the long bones of the leg, such as the femur. This is possible because the human body represents a certain unity of structure, and the relationships computed from the measurements of thousands of complete modern skeletons can be applied, within reasonable limits, to the reconstruction of ancient fragmentary remains. The size and shape of the muscles and fleshy parts of the body can also be accurately estimated from certain earmarks that appear on such bones as may be found. The diseases of primitive man, especially rachitis and tuberculosis of the bone, are sometimes clearly evident even in very old specimens. The age and sex of the person can be determined as a rule, provided the fossil skeleton includes the few particular bones which are most markedly divergent in the two sexes. A detailed account of the methods involved in making anthropometric measurements upon the human skeleton will be found in manuals by Hrdlička (31) and by Wilder (42). In most cases these methods are highly refined and well standardized which argues strongly for the validity of fossil reconstructions.

Since the skull of the human fossil is nearly always recovered, the indices based upon skull measurements are of special interest and importance to the student of human evolution. The general size and configuration of the brain can be determined from an analysis of the reconstructed skull and from endocranial casts. The advance in the elaboration of the neopallium, running through the fossil series, can thus be followed in a general way at least. The cranial capacity is measured in terms of cubic centimeters by filling the skull with liquid, millet seed, shot or the like, and then emptying the contents into a graduated glass tube. The index varies somewhat with the method and material utilized, millet seed, for example, giving an index of 50 to 100 cubic centimeters less than shot. The gen-

eral shape of the head is expressed by the cranial index which corresponds to the cephalic index of living specimens, except that it is computed at two units less because of the absence of skin and other tissues. The cranial index is secured by dividing the maximal breadth of the skull multiplied by 100 by the maximal length, which yields a percentage value. Specimens with a cranial index below 75 are classed as dolichocranial, those with an index ranging from 75 to 80 as mesocranial, and those with an index of 80 or above as brachycranial. These three types are popularly known as long or narrow heads, mediums, and round heads respectively. The nasal index also yields three types, the leptorhinic, mesorhinic, and platyrhinic depending upon the relative breadth and length of the nose. Prognathism, or the degree of the protrusion of the jaws is shown by the facial profile angle. These and numerous other head measurements enable the comparative anatomist, or the physical anthropologist to interpret properly the evolutionary significance of skeletal remains with fair exactitude.

Our knowledge of the arts and customs of early man is based upon recovered implements and other evidences of human handiwork. Although such artifacts are somewhat rare from the earlier ages, cultural materials are much more plentiful than fossil remains when corresponding periods are considered. The general order of cultural stages, beginning with the Eolithic age of late Pliocene and closing with the Iron Age of the early historic period, is shown in Figure 12. This outline is based upon the type-stations and chronology of the European region, since this has been most carefully investigated, but the main levels there established are regarded as applying generally. This means that the Eolithic, Paleolithic, Neolithic, Bronze, and Iron levels represent the necessary steps by which primitive man in any locality approached the

Period	Ice Age Chronology	Cultural Chronology	Human Types
RECENT *Holocene* (30,000 Years)	Post-Glacial	Iron Age Bronze Age Neolithic Mesolithic { Maglemosean, Azilian-Tardenoisian	*Homo sapiens* (Modern Man)
QUATERNARY *Pleistocene* (970,000 Years)	IV Glacial (Würm) 3 Interglacial (Riss-Würm) III Glacial (Riss) 2 Interglacial (Mindel-Riss) II Glacial (Mindel) 1 Interglacial (Günz-Mindel) I Glacial (Günz)	*Paleolithic* Upper { Magdalenian, Solutrean, Aurignacian Lower { Mousterian, Acheulean, Chellean, Pre-Chellean	Crô-Magnon Man *Homo neandertalensis* (Neandertal Man) *Homo heidelbergensis* (Heidelberg Man)
TERTIARY *Pliocene*	Preglacial	*Eolithic* { Foxhallian (Red-crag), Ipswichian Sub-red-crag	*Eoanthropus dawsoni* (Piltdown Man) *Pithecanthropus erectus* (Java Ape-Man)

FIGURE 12. THE CHRONOLOGY OF PREHISTORY
(Modified from MacCurdy)

(From MacCurdy, George G., "Human Origins," 2 Vols. D. Appleton & Company, 1926.)

status of civilisation. These several stages, however, involved numerous differences in the specific type of artifacts or traits developed in various communities. Specific cultural characteristics of this sort depend upon the kind and quality of materials available within the region for the making of artifacts as well as upon the development of local techniques. The primary cultural levels were not

reached simultaneously by different peoples and in different localities, the rate of cultural advance being much slower in some cases than in others. It is well known, for example, that northern Europe emerged from the Paleolithic stage much later than did Egypt and parts of Asia, while remnants of the old stone culture still survive among certain primitive peoples of to-day. In general, it may be said that all of the early types of man not belonging to the genus Homo, and all of the species of this genus, except *sapiens* or modern man, became extinct before advancing to the highest level of the Paleolithic or Old Stone culture.

The rate and direction of cultural progress is determined to some extent by climatic and other general conditions. This fact is well illustrated by the situation of primitive man in the northern hemisphere during the several glaciations of the Pleistocene epoch, as indicated in Figure 12. The cold moist glacial periods drove the fauna of the northern lands southward, while the warm and dry interglacial periods brought the sub-tropical fauna northward. These climatic conditions also determined in some measure the range of territory available for human habitation from time to time. The nature of the food supply and the type of implements and shelter required must have shifted considerably in passing from glacial to interglacial periods. Such general changes in environmental conditions ought to be favorable, on the whole, to cultural advance, since new inventions are usually necessary to meet new situations. In spite of the impetus to inventiveness, however, the advance of ancient man even in the practical arts was extremely slow up to the time when metals came into general use. Imitation and conservatism appear to have been the rule to such an extent that at times a hundred thousand years brought nothing of importance in the way of cultural progress. During these earlier ages man led

a nomadic existence and merely took from nature what might be wrested therefrom by crude implements. He lacked the motivation for continued improvement which usually characterises a settled mode of life with its cumulative tradition of cultural accomplishment. This appears to explain in large part the general lack of invention and constructiveness which contrasts so sharply with modern conditions. It is noteworthy also that crude tools often survived for ages along with the newer and better types which had been devised. On this account, it is usual to rate a given primitive culture on the basis of the best artifacts to be found therein.

The actual record of man's cultural evolution, as we now know it, begins with the Eolithic age of late Pliocene times, which dates back about a million and a half years. However, the crudely chipped stones which have been termed eoliths should not be thought of as representing the first stage of human stone-craft. As a matter of fact the known Eolithic culture was most likely a fairly advanced stage in which the methods of flaking, developed much earlier, had come to be regularly utilised. A long period of previous cultural development would seem to be indicated here, if we assume that the emergence of man took place in Middle Pliocene times, or approximately four million years ago. Perhaps, at first, primitive man selected wooden and stone objects suitable for implements and then cast them aside when they had served the immediate purpose. The scarcity of suitable natural objects, or some newly developed need, would lead him to modify pieces of wood or bones and stones for specific uses from time to time. We do not know when such improvisations gave place to the making of implements so well wrought as to be retained and treasured. There is some reason to suppose that the earliest culture of the latter sort utilized wood rather than stone in the main. The limbs of trees

would be somewhat easier to shape into rough implements under the primitive conditions that existed. Because of the perishable nature of wood, there is small chance of securing direct evidence on this point unless, as seems unlikely, petrified wooden implements from this remote age should sometime be discovered. When flint and similar materials finally became dominant, a long period of trial and error would still be necessary before definite methods of flaking, of the Eolithic type, could come into general use. As we have noted above, inventiveness was at a low ebb even at much later stages of cultural evolution. Progress must have been slow indeed during this period of transition from the ape-like habits of primeval man to the simple art of human constructiveness.

The cultural background of primitive man from stage to stage can be reconstructed at present only in a general way. The implements of stone, bone, horn, and metal usually betray the primary uses to which they were put, and thus reveal much concerning the habits and customs of ancient man. This is less true, perhaps, of the later periods when the artistic and ceremonial motives came into play. Many phases of prehistoric culture cannot be known because they do not happen to be reflected in the non-perishable remains that have come down to us. Nevertheless, it is possible to outline the main stages of advance and to show the more important trends in cultural evolution. Even when this has been done, however, there remains the task of fitting such human fossils as have been discovered in various places into the cultural scheme and thus securing a genuine unity in the drama of human evolution. One difficulty arises from the fact that some of the earlier fossils were found without associated artifacts so that their cultural position is difficult to determine precisely. Similarly, some of the earlier cultural stages have yielded as yet no fossil remains. Moreover, even when

both fossil and artifact are found together, some question arises as to whether they belong to the same age until we reach the period when ceremonial burial of objects with the dead became common. The correlation of skeletal and cultural materials offers a problem only during the ages which preceded the appearance of the cave man in Mousterian times. From this point onward, the human record is replete with fossil material discovered in its natural cultural setting.

Eolithic Man

As we have previously noted, the Eolithic or Dawn Stone Age represents the beginning of the definite record of man's cultural evolution. This age covers a period of about half a million years, in so far as at present revealed by archeological findings, and immediately precedes the Paleolithic, or Old Stone age as indicated in Figure 12. It would not be surprising, however, if future discoveries should enable us to extend this phase of ancient stone-craft backward another million years or so. Such a notion seems to be supported in some measure by the relatively complex character of certain eoliths found in the Ipswichian and other very old deposits. Moir concludes, for example, that the rostro-carinate, or eagle-beak type of eolith, was a natural development from two other types representing still more primitive stages of stone-craft. The earliest of these was merely a tabular piece of flint with a hollow flaked out on one edge, this being followed by one of similar pattern except that the opposite edge was also hollowed out by flaking. The rostro-carinate was developed at length from this latter design. This whole series of changes had taken place by the time the Ipswichian deposits were laid down at the latest. A typical rostro-carinate from this deposit is shown in Figure 13, and the

temporal position of the deposit in Figure 12. This line of evidence seems to indicate the occurrence of simpler Eolithic levels at a period considerably antecedent to the Ipswichian stage. If the record could be traced backward far enough we would doubtless find that the earliest eoliths were so crudely flaked that they would scarcely be recognised as such when found. In general, the Eolithic age may be regarded as including the very beginnings of human stone-craft and hence as extending backward to an unknown but exceedingly remote time.

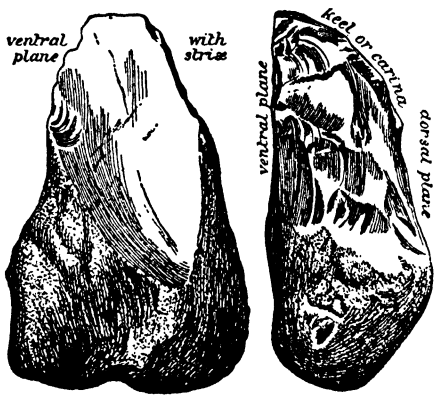


FIGURE 13. A Rostro-Carinate from the Sub-Red Crag, showing the ventral plane made by a single blow, the keel or carina, the dorsal plane, and the smooth round surface to be grasped by the hand. One-third natural size. From Osborn, after Reginald A. Smith, 1926. (From Osborn, H. F., "Man Rises to Parnassus." Princeton Univ. Press, 1927.)

Perhaps some mention should be made of the "eolithic controversy" in this connection, although the matter is now one of historical interest. The controversy involved the genuineness of eoliths, and arose in part because of the prevailing prejudice against the notion of Tertiary man. The orthodox view a generation ago was that man had emerged from the ape-stock during the Pleistocene or glacial epoch. In fact, the latter epoch together with the recent or post-glacial period is still known as the Quaternary, or age of man, as indicated in Figure 12. The discovery of eoliths of undoubted Pliocene age constituted undeniable evidence for Tertiary man, provided their status as genuine

artifacts could be established. Some of the eoliths first discovered were extremely crude and did not appear to be essentially different from stones shaped by such natural forces as glacial action and the like. Many scientists were inclined to regard them merely as natural imitations of human artifice, and numerous attempts were made to produce them under conditions more or less similar to those likely to occur in nature. As Moir (36) has recently shown, however, the flaking produced on nodules of flint, when subjected to fortuitous percussion or pressure, differs markedly from that of the eoliths. Among other differences he found that the flake-scars of an eolith show a constant angle because of the definite technique used in flaking, while the scars of flints shaken together violently in a bag exhibit no such regularity. The Eolithic problem was solved in part by the finding of the rostro-carinate and other types which clearly require a considerable degree of human skill in the making. Moreover, the probability of stone-craft in late Pliocene times was greatly strengthened by the discovery of fossil evidence for Tertiary man. It is interesting to note that a similar controversy had occurred earlier when the genuineness of paleoliths was called in question.

Although indications of earlier Eolithic stages are not wanting, we shall limit the present discussion to the Bramford or Ipswichian and the Foxhallian cultures of the European chronology. The Bramford and Foxhall quarries are both located near Ipswich in East Anglia and have been well explored by the British archeologist, J. Reid Moir. The Sub-Red Crag deposit rests directly upon a chalky layer of Cretaceous age containing flint pebbles and nodules. The deposit itself is characterised by a few flints and the presence of fossil remains of southern elephants and other Pliocene fauna. In addition to the rostro-carinates, numerous types of small eoliths were found

which were very similar in pattern to the side scraper, borer, chopper, etc., of the later Pre-Chellean culture. Some of these were flaked on both faces and might well be classified as Pre-Chellean except for the fact that the Sub-Red Crag is undeniably of Pliocene Age. Not only these smaller eoliths but the rostro-carinates as well definitely link up the Eolithic age with the Paleolithic age. For, as Moir has shown, the rostro-carinate continued to be used in Pre-Chellean times, although it was gradually being displaced by the hand-axe. Moreover, this writer attempts to show that the rostro-carinate pattern occurs with modifications in certain types of later paleoliths until the new flake culture of Mousterian times came in. Apparently it was a general purpose tool to Eolithic man just as the *coup-de-poing* or hand-axe was to Lower Paleolithic man. The smooth rounded end was unflaked and fitted snugly into the palm of the hand. The sharp keel or carina, as Osborn has suggested, would be effective in removing the hide from an animal and in cutting the skin. Rostro-carinates have been found in deposits in various parts of England, in Kent's cavern in north Ireland, and in France and Egypt, although all of these are not of equal age. This fact would seem to indicate that the eagle-beak was a common element in a widespread Eolithic culture and not simply a local development.

Several horizons have been recognised in the Red-Crag deposits of Foxhall, all of which are regarded as of Pliocene age. The rostro-carinate type appears to be scarce at all levels in so far as these have been explored, but small flints are present in considerable numbers. The following types of eoliths from Foxhall are listed by Osborn: (a) *coup-de-poing* or hand-axe flaked on both sides, (b) primitive arrowhead, (c) primitive *rêcloir* or scraper, (d) primitive *pointe* or spearhead, and (e) primitive *perçoir* or borer. Some of these were fashioned from cores

while others were shaped from flakes. In excavating the site, Moir came upon a flint-working floor where the man of Foxhall brought flint nodules and constructed his implements. Typical eoliths were found at this point representing all stages of manufacture along with discarded cores and flakes. He also discovered a fireplace at one level and numerous stones which exhibited cracking and other evidences of having been subjected to the action of fire. It is well known that primitive man sometimes calcined flints by fire as one means of shaping them, and the burnt flints of Foxhall suggest that this technique was known to man at this early period. We do not know just when the use of fire and the knowledge of how to make it by striking flints, or by rubbing sticks together first originated. Doubtless man secured fire from lightning conflagrations and turned it to practical use long before he had learned how to make it. The fire obtained from nature on occasion was probably carefully preserved, being nursed along and transferred from hearth to hearth. While we may be certain that Foxhall man made use of fire in some manner, the matter of whether or not he had acquired the art of making fire himself is left in doubt.

The Ipswichian and Foxhallian deposits have yielded as yet no skeletal remains of man. This is especially unfortunate since a strict correlation between the structural and cultural characteristics of Eolithic man is thus rendered impossible. Nevertheless, two fossil types have been found elsewhere which are usually assigned to the late Pliocene epoch and these should throw some light upon the structural status of man at this time. The oldest of these is, perhaps, Pithecanthropus erectus, or the ape-man of Java, the other being Eoanthropus dawsoni, or the Piltdown man of Sussex, England. Both of these types are exceedingly ancient, and are thought to have antedated the appearance of the genus Homo, as indicated in Figure 11. They are

not directly ancestral to later man, but represent collateral stems, being in fact the only extinct generic types that have been discovered up to the present. Their classification as distinct generic types implies, of course, that they are not closely related to each other. We might suspect as much from the fact that the skeletal remains were found in localities so distantly separated. It is evident that they arose from stocks which migrated very early from the homeland of central Asia. Pithecanthropus represents a migration southward into Java which was then a part of the Asiatic mainland. The stock from which Eoanthropus, or the Dawn Man arose, moved westward into England which was still a part of the mainland of Europe at the close of Pliocene times. The two fossils differ markedly in structural characteristics, as we shall find, and serve to illustrate in a concrete manner the evolution of generic types growing out of early human migrations.

Pithecanthropus erectus was discovered in 1891 by Dubois in a river deposit near Trinil, Java, under conditions which leave the precise age of the specimen somewhat in doubt. The fragmentary remains recovered included the skull cap or calvarium, the femur of the left leg, and two teeth, a third being added later. Measurements indicate a dolichocranial skull, a low and sloping forehead, and large supraorbital processes which account for the beetle-browed appearance of the reconstruction shown in the Frontispiece. The cranial capacity is usually given as 940 cubic centimeters, which places the brain size near the lower limit of modern man and far above the upper limit of the largest known gorilla, which is set at 600 cubic centimeters. Endocranial casts show the brain to have been distinctly human in type, with a well-marked speech center and motor area, the frontal lobe, however, being somewhat under-developed. The left hemisphere was larger than the right, indicating right-handedness, and

suggesting that this stock had long since adopted definite habits in the manipulation of tools. The teeth are distinctly more modern than those of the later Neandertaloid stock, being of the cynodont, or dog-tooth type rather than of the taurodont, or ox-tooth variety. The femur shows the bodily skeleton to have been human, the relatively straight thigh suggesting that the Java man probably stood nearly as erect as the man of to-day. The fact that the skull and face are much more ape-like than the limbs has been interpreted by some to mean that the evolution of erect bipedism in man preceded the appearance of the large and fully elaborated modern brain. Numerous species of extinct Pliocene mammals were found associated with the fossil, and such authorities as Dubois, Gregory, and Keith regard it as of late Pliocene age. This has been questioned recently by Osborn (38) who prefers to regard it as a backward Neandertaloid type of Pleistocene age, as indicated in Figure 8. Since no associated artifacts have been recovered, no definite statement can be made regarding the cultural level of the man of Java.

Eoanthropus, or the Dawn Man of Sussex, was discovered in 1911 by Dawson, near Piltdown, which is only a short distance from the sites of the Ipswichian and Foxhallian cultures. The original find included several fragments of the skull, a portion of the lower jaw, and a canine tooth. In 1915, two fragments of another skull, and a molar tooth, were found about two miles distant, and these doubtless belonged to another specimen of the same general type. The skull of Eoanthropus is unusually thick even for primitive man, and is somewhat dolichocranial in form, with a moderately high vault. The forehead is higher and less sloping than in the Java man and the supraorbital ridges so marked in the latter are almost entirely absent. The jaw is relatively massive and ape-like, giving a chinless face, as shown by the reconstruction in the Frontispiece.

The cranial capacity is usually given as 1240 cubic centimeters, or approximately 300 units greater than that of Pithecanthropus. The brain of Piltdown man was better developed than that of the man of Java in general, and especially so in the frontal lobe region. The teeth are more primitive, however, the length being greater than the breadth which is not true of the teeth of Pithecanthropus. The indicated poising of the skull seems to show that the Piltdown man walked erect after the manner of modern man. Several authorities refer this type to early Pleistocene times in spite of the fact that it was found in Pliocene gravel in association with the bones of Pliocene mammals. On the whole, it would seem somewhat incongruous to place Piltdown man with his eoliths in the Paleolithic chronology.

Moir and others in England and Osborn in America have sought to connect the Piltdown man with the Eolithic culture of nearby East Anglia. Osborn has called attention to the remarkable resemblance of the implements found buried with this fossil to the small eoliths of the Foxhallian level. Those who reject the Pliocene age of Piltdown man do so mainly on the ground that the brain is larger and better developed than might be expected in man of Tertiary age. This latter assumption would seem to be based upon questionable logic since there are no facts at hand to support it. The small brain cube of Pithecanthropus constitutes the only other bit of direct evidence we possess regarding the probable brain size of Tertiary man. There seems to be no good reason, however, for taking the brain cube of Pithecanthropus as the standard for Tertiary man generally. It might be assumed with equal logic that the brain cube of Piltdown man was typical of the human stock in late Tertiary times. As a matter of fact neither assumption need be made, and both seem to rest upon the discarded notion that human fossils can be

arranged in a linear series on the basis of single characters. It should be borne in mind that the Piltdown and Java fossils belong to distinct generic types, widely separated from each other, and evolving for ages under markedly divergent environmental conditions. Moreover, there is some reason to suppose that these conditions were favorable to the evolution of a progressive type in the former case and not in the latter. The larger and better developed brain of Piltdown man might well be one distinctive characteristic of this generic type of Eolithic man. The Pithecanthropus stock, on the other hand, may represent the opposite extreme in this respect. At any rate, brain cube cannot be stressed in determining the chronology of fossil specimens until enough skeletal material of Eolithic age has been found to warrant the setting up of a general standard.

The existence of Eolithic man during late Tertiary times would seem to be well established by the numerous facts cited above. Nevertheless, it is impossible to interpret the life of Eolithic man in its broader aspects at present. The bits of evidence, although valid enough in themselves, are too unrelated to schematise in any very meaningful way. Moreover, a concensus of expert opinion has not been reached as yet on several pivotal points. The difficulty is due not so much to lack of facts as to the inability to bring the skeletal and cultural materials under a common chronology. The problem at this point is well illustrated by the case of Pithecanthropus. The immense value of this fossil in revealing a certain stage of man's evolution cannot be questioned. But almost nothing is known of the cultural background of the human stock which it represents. The small brain and ape-like features suggest a level of culture no higher than the Ipswichian, and perhaps one much lower. But in the absence of any associated artifacts, a conclusion of this

sort cannot be safely drawn. For the present, at any rate, it is impossible to fit this important fossil into any definite position in the Eolithic age. The link between Piltdown man and the Foxhallian or some closely related culture level seems to be fairly well established on the basis of artifacts alone. However, the Pliocene age of the Piltdown fossil is still in question, and, therefore, it seems premature to place it definitely in the larger cultural background of the finds of East Anglia. If future analysis or discovery should establish the Pliocene age of this fossil a reconstruction of the late Eolithic age would become possible. A more definite connecting link would thus be formed between late Tertiary man with his Eolithic culture and early Quaternary man with his Paleolithic culture.

Early Paleolithic Man

It is generally supposed that Eolithic or Tertiary man became extinct in Europe and elsewhere about the opening of the Pleistocene or glacial epoch. No one can say precisely what led to the passing of either of the two known generic types, Pithecanthropus or Eoanthropus. The former was probably exterminated by a stock of large-brained migrants, belonging to the genus Homo which swept southward from the Asiatic center of dispersion. Perhaps Eoanthropus met a similar fate at the hands of another band of migrants of the same genus which moved westward into Europe about the same time or a little later. It seems just as likely, however, that the Piltdown stock was forced by the onset of the first glaciation to turn southward and enter the territory then occupied by more progressive types. Here they were either exterminated entirely or became amalgamated, if any were spared, with the stocks then living in central and southern Europe.

Whatever the precise course of events, we know that various species of the genus Homo had spread over Eurasia and much of Africa by the opening of the ice age. The skeletal and cultural traces of man, from this time forward, relate to stocks belonging to the genus Homo, indicating the probable extinction of the more ancient generic types. Only two species of early Paleolithic man have so far been discovered—heidelbergensis and neandertalensis, although there may have been others for all we know. If Heidelberg man be regarded as an early specimen directly ancestral to Neandertal man, as is sometimes done, both can be thought of as a single species. In such a classification, early Paleolithic man becomes identified with the Neandertaloid stock.

The age of early Paleolithic man was exceedingly extensive since it included all except the last seventy thousand years of the million-year Pleistocene epoch. It comprises an unbroken series of culture stages leading up to and including the Mousterian, as indicated in Figure 12. This latter stage, covering a period of about 200,000 years, is sometimes singled out and termed Middle Paleolithic. There seems to be no good reason for breaking the continuity in this manner, however, since the Mousterian stage is merely the natural culmination of the cultural evolution of Neandertaloid man. The names of the various culture levels are taken from the type-stations on which the European chronology is based. Artifacts distinctive of each level have been found, however, at widely separated points in Eurasia and Africa, as may be seen by consulting MacCurdy (35) and other handbooks. In fact, it is clear that the dominion of the Neandertaloid stock extended over most of the habitable regions of the Old World. This situation offers a good illustration of the importance of the ethnic factor in the evolution of human culture. Neandertaloid man, with his strong body and

large brain, passed through essentially the same cultural stages, regardless of the environmental differences which obtained between various localities. It appears significant, moreover, that none of these local groups advanced beyond the Mousterian stage of culture with almost a million years of opportunity. This suggests the presence of inherent limitations within the Neandertaloid strain, and we are not surprised to find that the type was finally exterminated by Homo sapiens of Upper Paleolithic times.

The presense of rostro-carinates in some of the Pre-Chellean deposits would seem to link the Eolithic and Paleolithic cultures in a definite manner. The chief tool of Pre-Chellean times was the large flint core which may be regarded as the prototype of the Chellean hand-axe or cleaver. These cores were usually flaked more or less completely on both sides except at the butt, although the chipping was crude and the implements heavy and awkward. Some of the giant flints discovered near the forest-bed of Cromer, located about 50 miles east of the Foxhall quarry, have been found to weigh well over seven pounds. These flaked cores were probably not hafted since one end was usually left smooth, after the manner of the rostro-carinates, to serve as a handhold. The Chellean *coup-de-poing,* hand-axe, or cleaver, was somewhat lighter in weight than the Pre-Chellean core and was much more smoothly flaked. A typical specimen is illustrated in Figure 14, although a considerable variation in size and shape occurred. As MacCurdy has remarked, this implement was probably put to such varied uses as cleaving, chopping, skinning, scraping, sewing, and the like. The cleaver tended to become still lighter in weight in Acheulean times due to the thinning down of the body of the core. It also possessed a sharper and more regular edge because an improved technique had led to the removal of much smaller flakes. The size of the implement in Acheulean deposits

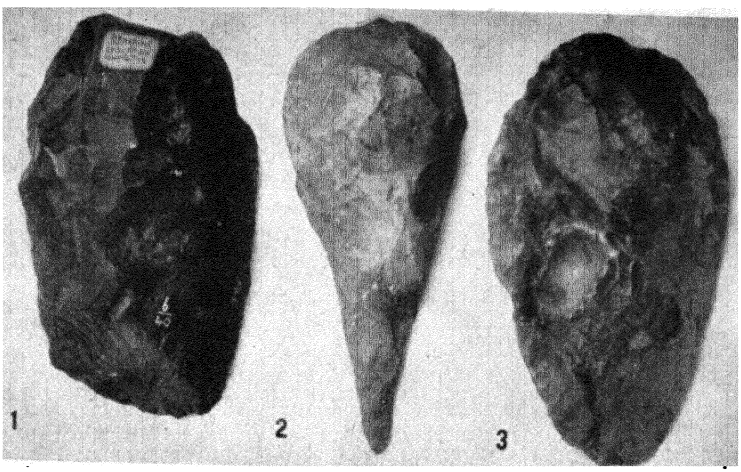


FIGURE 14. IMPLEMENTS *(COUP-DE-POING)* TYPICAL OF THE EARLY PALEOLITHIC AGE

(1) Hand-ax or chopping tool of flint (Chellean). (2) Dagger or perforating tool of flint (Acheulean). (3) Implement of flint for various purposes, such as cutting and scraping (Mousterian). (From *American Museum of Natural History Leaflet*, No. 52. Fifth Edition, 1929, by Osborn.)

ranged from two to twelve inches in length. Among the many patterns developed one which may have been used as a dagger or as a perforating tool is illustrated in Figure 14. Numerous small implements, formed largely from the flakes removed by means of the hammer-stone in making the primary tool, are found in each of these cultural levels. These become more varied in type and exhibit better workmanship as we pass from Pre-Chellean to later stages. Such accessory tools included knives, saws, scrapers, points, scratchers, spokeshaves, borers, and many similar types, some of which are difficult to classify.

The distinguishing mark of the Mousterian industry was the use of the flake instead of the core in tool construction. The flakes so utilized were struck off by a new method and were very different from the small chips produced in making instruments of the core variety. They were larger and possessed a more prominent bulb, and the plane of percussion was small and faceted. The core itself was discarded when as many flakes as possible had been removed from the prepared flint nodule. This new flake industry led to the degeneration of the cleaver, which disappeared entirely before the close of Mousterian times. The point and the scraper were the two main types of flake instruments employed, although scratchers, gravers, drills, saws, and the like were also common. The point was similar in general shape to an elongated triangle, and the two margins running from the tip to the bulbar portion were chipped on one face only. It could be used not only as a piercing tool but also as a knife, saw, or scraper, since the margins were sharp. According to MacCurdy, the point was the prototype of the two-edged pointed knifeblade, and possibly of the arrow-head and spear-head. The scraper was somewhat larger than the point and less triangular, was usually chipped on one face only, and served as a knife in skinning, carving, and chopping. It was sometimes made

into a sort of axe by chipping both faces along the lower margin, and as thus employed it may have been hafted. The tools of this period were retouched when they became dull, small secondary flakes being removed along the edges by the application of a bone compressor. In addition to the latter instrument, a few other bone tools made their appearance before the close of this period. In certain late Mousterian deposits, for example, an implement for skinning has been found which was made from one-half of the fibula of a cave bear, broken obliquely near the middle and polished for use. A genuine bone culture did not arise, however, until Upper Paleolithic times.

The fossil record of early Paleolithic man previous to Mousterian times is limited to a single fragment discovered in 1907 by Schoetensack in the Mauer sands near Heidelberg, Germany. The find consisted of a complete and well-preserved lower jaw buried at a depth of nearly eighty feet in the river valley deposit. The jaw is heavy and massive and like that of Eolithic man gives evidence of a markedly retreating chin. The teeth in the ape-like jaw are distinctly human, rather small in proportion to the size of the jaw, and are of the taurodont or ox-tooth variety. This type of tooth has short spreading roots, a large pulp cavity, and a wide crown, and is characteristic of the Neandertaloid stock as a whole. The teeth of the great apes, Eolithic man so far as known, and modern man belong to the cynodont, or dog-tooth variety, with deeper roots, smaller pulp cavity, and a narrow crown. The taurodont tooth is regarded by Keith as a special adaptation of Neandertaloid man to a restricted and harsh herbivorous diet. No trace of the skull of Heidelberg man was found but the reconstruction by McGregor indicates that it was in many respects similar to that of later Neandertal man. It seems to have been dolichocranial, with low forehead and prominent brow ridges, and the cranial capacity is

usually given as 1070 cubic centimeters. The chinless ape-like jaw and small cranial capacity have led some writers to consider Heidelberg man a descendant of the man of Java, but the difference in location argues strongly against this notion. The many points of similarity between Heidelberg man and Neandertal man suggest that the former was directly ancestral to the latter and hence may be included with the Neandertaloid stock. Since no human artifacts have been found in the Mauer sands, the cultural position of Heidelberg man cannot be determined on the basis of direct evidence. The jaw was found associated with warm fauna, which some regard as Pre-Glacial but which others assign to the First or Second Interglacial. In any case, this would mean that Heidelberg man represented some stage of Pre-Chellean culture.

The term Neandertal man is generally applied to the Neandertaloid stock of Mousterian times regardless of the locality in which fossil specimens occur. The name was first used in connection with a human skeleton found in 1857 near the mouth of a cave in the Neandertal valley not far from Düsseldorf, Germany. It has since been extended to include the Gibraltar skull discovered earlier and some fifty or more fossils of later date. The skeletal remains of Neandertal or Mousterian man as at present known are almost as widely distributed as the culture itself. Specimens have been found in various parts of Europe, Asia, Asia Minor, and in both North and South Africa. This type is represented by many famous fossils, including the following in addition to the two mentioned above: Spy, Ehringsdorf or Weimar, Krapina, Rhodesia, Le Moustier, La Chapelle-aux-Saints, La Quina, Galilee, and perhaps the Peking material recently discovered. The widespread occurrence of Neandertal man can only be explained by supposing a general dispersion of the common type in

several directions from the Asiatic homeland. This would also account for the very considerable range of variation within the stock which becomes apparent when fossil specimens from widely separated regions are compared. Even if we do not regard Heidelberg man as directly ancestral to Neandertal man, the dispersion of the latter type must have taken place as early as 300,000 years ago. If Heidelberg man be included this time estimate must be raised to something like a million years.

The Neandertal type was stocky in bodily build, with short, massive, and large-jointed bones, and powerful musculature. The males averaged about five feet three inches in stature, and the females fell slightly under the five foot limit. A low degree of spinal curvature, definitely curved thigh bones, and other skeletal peculiarities indicate that he assumed a slouching attitude with the knees somewhat bent in walking. His head was large and brutish in appearance and protruded forward from a short and thick-set neck, as illustrated in the reconstruction shown in the Frontispiece. His teeth were of the taurodont or ox-tooth variety and hence similar in general to those of the man of Heidelberg. In spite of his decided prognathism and recessive jaw, a slight reduction of the dentary bone in this type marks the faint beginnings of a chin line. The skull is dolichocranial and low vaulted and the slope of the forehead is exaggerated by the presence of a large supra-orbital crest similar to that in Pithecanthropus. The average cranial capacity, according to MacCurdy, is about 1400 cubic centimeters, although that of the adult male of La Chapelle-aux-Saints measured 1600 units. MacCurdy thinks the cranial capacity of Neandertal man is roughly comparable to that of modern savage races when differences in body mass are taken into account. Endocranial casts indicate that the speech and motor centers were both well developed, while the frontal lobe was relatively small and

simple in structure. The left hemisphere was larger than the right and the right arm was measurably larger than the left. The same was probably true of Eolithic man, as we have seen, and indicates the preferential use of the right hand in the construction and use of implements and in other activities. On the whole, Neandertal man appears to have been a strange congeries of ape-like and human features. His posture was clearly more simian than that of either of the two types of Eolithic man. However, his brain was larger and more like that of modern man, and this superiority was reflected in a higher type of stone-craft and in many other ways.

Our knowledge of the cultural background of early Paleolithic man must be drawn almost entirely from his flint industry. These remains are found, for the most part, in river drift deposits up to Mousterian times, and thereafter in rock shelters and caves. This seems to show that the pre-Mousterian, or Heidelberg stock, roamed the plains and river terraces in search of food, keeping close to the larger streams which would furnish a year-round water supply. We have no certain way of knowing whether this early Neandertaloid type lived on fish and game or on a coarse vegetable diet as his teeth seem to suggest. None of his stone implements would be of much use in catching fish, but the cleaver could have been employed to strike down large game when they approached his hiding place. We may infer that he possessed fire from the fact that this important element of culture was known to Eolithic man, but he may not have been able to make it at will. The cold climate of the glacial periods suggests the need not only of fire but also of clothing, unless man at this time was still covered with hair like his anthropoid ancestors. If clothing were worn it probably consisted of an animal skin thrown over the body, since even Mousterian man possessed no tools for sewing. Nothing

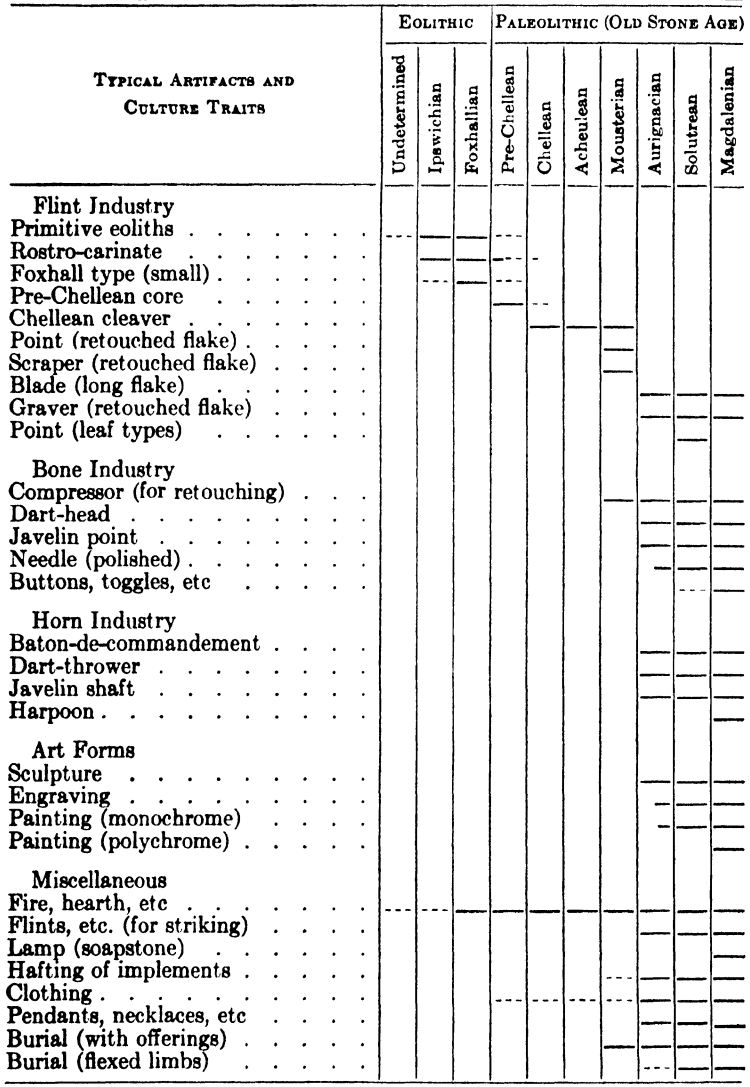


Figure 15. The Growth of Culture during the Eolithic and Paleolithic Ages. The presence of the artifact or trait is indicated by a solid line and its probable occurrence by a dash line.

directly is known of the social life of man at this stage. Doubtless the anthropoid family life had been modified in numerous ways, but we have no hint as to the nature of such changes. That man lived in fairly large groups cannot be doubted, but we know nothing of the type of social organization that existed. Some sort of group leadership certainly must have arisen in connection with the great migrations and the more usual hunting expeditions. The presence of flint-working floors suggests that there may have been a division of labor also, special recognition being given to those who became expert in making implements.

The opening of the Mousterian epoch coincided with the onset of the Third, or Riss glaciation, and marked the beginning of the cave life of Paleolithic man. The rock shelters and caves offered much better protection than the improvised constructions of pre-Mousterian man and became important centers of group life. It was necessary for man to drive out the cave-bear and other ferocious animals and probably this was accomplished by the use of fire. The same agency was employed to protect the cave afterward, the large hearth at the mouth being characteristic of Mousterian and later times. The presence of burnt bones in the refuse about the hearth suggests that some simple form of cooking, such as roasting, was also practised. While new and refined methods of stone-craft were developed, as we have seen, no evidence of a genuine artistic impulse made its appearance. Even the later implements were not ornamented in any way, and pictorial art on the cavern walls is wholly absent. The life of the times was apparently limited to the more practical problems of existence. In a few instances pigments have been found in Mousterian deposits, and these may have been used for personal decoration. Burial of the dead with votive offerings is first met with near the close of the epoch, but the custom does not seem to have been very widespread.

In any case, its occurrence would seem to mean that Neandertal man was superstitious, and, perhaps, held to some more or less definite belief regarding an after-life. The industry and life of early Paleolithic man reveals many elements of genuine progress when viewed as a whole. At its best, however, it was markedly inferior to the new culture which the invading Homo sapiens brought with him from the East, as Mousterian times drew to a close.

Chapter V

THE COMING OF MODERN MAN

We come upon the first traces of Homo sapiens, or modern man, in the European record at the beginning of Upper Paleolithic times, or approximately 100,000 years ago. This does not mean that the new species originated at this relatively recent date, but merely that the first westward migratory wave did not reach Europe until this time. As we shall see, the sapiens stock arose in central Asia at a much earlier period, and gradually spread to other parts, becoming diversified into the great racial types. The late arrival of the species in Europe and in other regions far distant from the center of dispersion is not to be wondered at when the nature of the migratory movements of early man are properly understood. These movements were seldom if ever forced marches directed toward a definite objective. On the contrary, they represented the natural wanderings of groups of people into contiguous regions through a long series of generations. So long as a given territory provided primitive man with the simple necessities of life, he and his descendants remained within it. The occurrence of drought and famine and the lure of an easy food supply ahead were probably the chief motives leading to a forward movement. The pressure of other groups of migrants from behind and the natural wander-lust of the nomad may have been contributing factors also at times. In any case, the rate of movement was slow because of such natural barriers as large rivers

and high mountains, since man had not yet devised even the most primitive means of transportation. The wheel did not make its appearance until thousands of years later, and the same may be said of the raft and boat as well. In brief, these early migratory movements represent merely the general drift of mankind away from the center of dispersion in various directions.

It is generally supposed that the sapiens stock arose in central Asia as early as the middle of the Pleistocene epoch, or something like a half million years ago. Sir Arthur Keith would extend the point of origin back into the latter part of the Pliocene epoch in order to give a sufficient time for the racial differentiation which has since occurred. His position seems plausible enough if we accept his time-scale which allows only a scant 200,000 years to the entire Pleistocene period. It loses its force, however, when this period is lengthened out to nearly a million years, as in the chronology of Figure 12, or even to a half million years, which is now regarded as a conservative estimate. According to the time-scale here adopted a half million years would be allowed for the racial diversification of the Homo sapiens stock, if we suppose the latter to have evolved by the middle of the Pleistocene epoch. This estimate would seem to be ample, and is approximately twice as long as that proposed by Keith. As a matter of fact, the time and circumstances relating to the evolution of the sapiens stock are largely matters of inference as yet. We know that this new level of human organisation was not reached until after the separation of the Neandertaloid species from the main stem. This separation most likely took place about the beginning of the Pleistocene epoch, although it may have occurred considerably earlier than this. The further evolution which culminated in the sapiens stock probably took place during the first half of the glacial epoch. The evolution of the large-brained Homo sapiens in Asia was

thus contemporary in part with the dominance of the older Neandertaloid species in outlying regions. The impetus to this new level of advance is not definitely known, although there is reason to suppose that the environmental conditions in central Asia favored the perfection of structural trends in the stock that remained. The early migrations already mentioned must have constituted another selective factor of importance, since they involved the continuous elimination from the parent stock of many large groups that had not as yet reached the level represented by Homo sapiens.

The appearance of this new species marked the last great advance in structural evolution and ushered in the age of modern man. Homo sapiens possessed a larger and better balanced brain than any of his predecessors. He was distinguished also by numerous refinements in bodily form and by superior manipulative skill and language capacity. In time, the natural increase in numbers in the homeland forced the species to spread over the earth, and to become diversified into the three great racial stocks—negroid, mongoloid, and caucasoid. Each of these ultimately split up into varieties or races. These various racial divisions represented further evolutionary changes of a relatively minor sort growing out of selective migration and regional isolation. The general trends of the major migratory movements are indicated on the map of Figure 16. The negroid, or black races evolved from the peoples that turned southward and finally pushed down into the middle and lower parts of Africa. The ancestors of the caucasoid, or white races also moved southward but finally settled in Europe, southern Asia, and northern Africa. This stock eventually separated into the three well-known European white races—Nordic, Alpine, and Mediterranean. The yellow-brown races arose from the mongoloid stock which remained for the most part in northern and central Asia.

In process of time, some of the mongoloids spread to the neighboring islands, while others migrated to North America over the Behring Straits land bridge and became the nucleus of the numerous Indian tribes. Although these ancestral racial stocks broke away at various times,

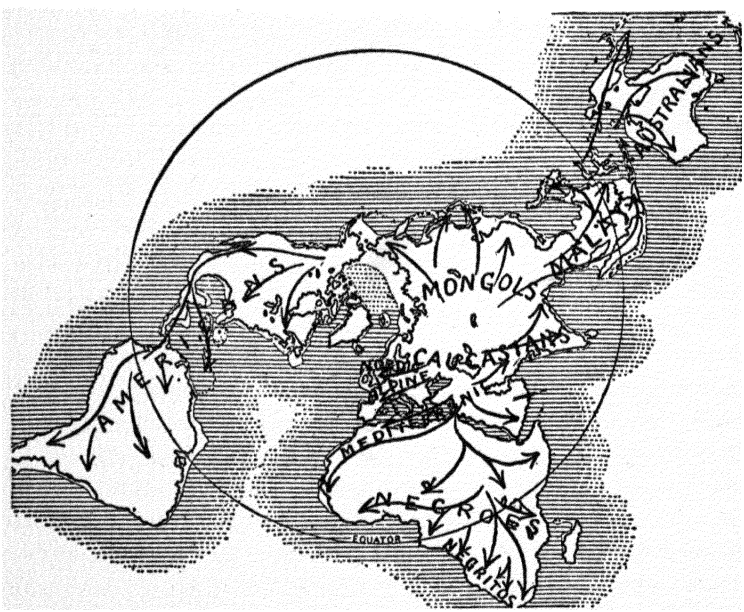


FIGURE 16. Theoretic Dispersal and Distribution of the principal races of man from his central Asiatic homeland. From Osborn, after Matthew, 1915. (From Osborn, H. F., "Man Rises to Parnassus." Princeton Univ. Press, 1927.)

and hence may have differed more or less from the first, they all possessed the basic characteristics of the large-brained Homo sapiens type. Most of the distinctive racial features of modern man probably arose after the radiation of their ancestors into divergent habitats. The nature and extent of these racial differences and their underlying causes will be discussed at length in the following chapter.

Very little is known at present regarding the chronological sequence of the migratory movements which led to the evolution of the great racial stocks. There is some reason to suppose that the ancestors of the negroid peoples were the first to leave central Asia and thus to become definitely separated from the common stem. In fact, it seems altogether likely that they were finally forced into the heart of Africa and southward by the ancestors of the more progressive caucasoids who swept down from the north at a later time. This course of events is in agreement with the principle set forth by Matthew that primitive races are continually being thrust out from the center of dispersion by more favored races. Another bit of evidence pointing in the same direction, based upon skin color, has been stressed by G. Elliot Smith as indicated in the diagram of Figure 11. It is generally supposed that there was a gradual reduction of pigment in the skin of Homo sapiens following the loss of his ape-like coat of hair. The fact that the negroid races have retained a heavily pigmented skin might well mean that their ancestors became separated from the main stem before this reduction had been carried far. The tropical environment under which they lived favored the retention of pigmentation, whereas the opposite was true of the other great racial groups, and especially so in the case of the caucasoids. If it should be certainly shown that the negroid stock split off from the parent stem earlier than the others, this would mean that the black races of to-day are less closely related to the caucasoid races than are the mongoloids. For it is true, of course, that the genetic background of successive migratory waves varied within limits, depending upon the kind and amount of evolutionary changes still taking place in the parent stock form time to time. The time of divergence as well as the selective aspect of migratory movements seems to offer a sound evolutionary basis for

definite hereditary racial characteristics of a morphological sort between the three great stocks—Negroid, Mongoloid, and Caucasoid.

We know almost nothing as yet concerning the cultural status of Homo sapiens prior to the invasion of Europe at the opening of Upper Paleolithic times. The stone-craft of the invader, while containing distinctly superior elements, was similar in many respects in its earliest phase to the Mousterian industry which it displaced. This means that Aurignacian man, representing the progressive caucasoid stock, had not advanced beyond a moderately high stage of stone culture as late as 100,000 years ago. The cultural status of other racial groups which had reached the outer fringes of Eurasia and Africa by this time was probably much lower than this. Perhaps a higher level of stone industry was then in process of development near the Asiatic center of dispersion, but even this must have been Paleolithic rather than Neolithic. It seems reasonable to conclude, therefore, that Homo sapiens had lived in a relatively simple stone culture in Asia during the greater part of the 400,000 years or so that had elapsed since the birth of the species. Whether the stages passed through were similar in general to those of the European region we do not know. Unfortunately, the culture chronology of Asia has not been worked out sufficiently to permit even rough correlations with the European chronology. We cannot be certain, even, as to the cultural background of primitive man in Asia at the time when Homo sapiens was evolved. If we suppose that the Pre-Chellean or early Chellean culture of Neandertaloid man was carried with him from Asia, it would follow that the later evolved Homo sapiens stock must have begun their existence at this or a somewhat higher cultural level. As a matter of fact, however, we do not know whether the earliest Lower Paleolithic culture was transplanted direct from Asia, or

developed in the European region as were the later stages. While nothing definite can be said, therefore, concerning the cultural background of early Homo sapiens, it is evident that this type advanced at a faster rate than did Neandertaloid man. In fact, it seems likely that he attained the Aurignacian level in Asia by the time his Neandertaloid cousin had reached the Mousterian stage in Europe.

The record of Homo sapiens is fairly complete in general outline from the beginning of Upper Paleolithic times onward in the European region. In fact the culture chronology of Europe, as indicated in the diagram of Figure 12, is based upon a wealth of recovered human remains. Other regions are less well known, but such finds as have been made favor the view that the same general order of advance was followed by man everywhere from this time forward. This means that the European sequence can be thought of as applying, with certain modifications in detail, to all parts of the world where the new species migrated. Northern Africa and southern Asia have yielded abundant archeological remains pertaining to certain stages, although the story of cultural progress in these regions is far from complete. Apparently these lands led Europe in general cultural advance, largely perhaps because they were more accessible to migrants coming from the center of dispersion. The early cultural status of central Asia is still unknown. The Asiatic theory would lead us to suppose that the main advances were first reached in this region and then borne to other lands by the successive migrations of Homo sapiens. The truth of the matter can only be determined by the direct evidence of archeological research. Because of the incompleteness of the record elsewhere, we must give most attention to the European fossil and cultural material in the present treatment. Important facts relating to other regions will be

cited whenever possible, however, in order to make the survey as nearly world-wide as our present knowledge seems to warrant.

Late Paleolithic Man

The new invasion of Europe began near the close of Mousterian times when the Neandertaloid supremacy was at its height in this region. The struggle against the invader which ensued should be thought of as the last stand of Neandertal man against the world-wide sweep of Homo sapiens. For the new species had long since wrested from him the more readily accessible portions of his once-extensive dominion. The caucasoid races were already securely established by this time in southwest Asia and had taken possession of the choice parts of northern Africa. They had exterminated the Neandertaloid stock in both these regions and had pushed the negroid races southward into the interior of the dark continent. The Nile valley then as now was a fertile land and, during the European glaciations, the vast Sahara desert region was favored by a copious rainfall. The warm interludes and the late post-glacial period, however, were marked by long and serious droughts, and a somewhat similar condition seems to have prevailed in southwest Asia as well. The peoples of both of these regions were forced to migrate, and Europe offered a more or less natural outlet. Some of them arrived in southern Europe during the Würm or last great glaciation, while others came as the ice-age was passing out. Whether Aurignacian man came from southwest Asia, northern Africa, or from both of these lands is still a moot question. The culture they brought was similar to the Aurignacian industry which had been developed earlier in both of these regions. The fossil evidence goes to show that the principal types were caucasoid, while some of the

races represented appeared to possess negroid affinities. In any case, we know that Mousterian man perished at the hands of the invader, approximately 100,000 years ago, and this event ended forever the long reign of ancient man.

The age of late Paleolithic man was relatively short, occupying only the last 70,000 years or so of the Pleistocene epoch. It coincided roughly with the Würm or last great glaciation, as indicated in the diagram of Figure 12. The fauna of Europe at this time included such cold climate types as the arctic mammoth, woolly rhinoceros, reindeer, cave-bear, cave-hyena, and wild boar. This age comprised three successive stages of culture—Aurignacian, Solutrean, and Magdalenian—named after the respective European type-stations. The Aurignacian culture was well distributed over Europe and the Mediterranean basin. A few sites have also been found in Asia Minor, and in Algeria and Tunis in Africa, the culture in the latter case being referred to as the Capsian. The recent excavations of Sanford and Arkell (40) enable us definitely to extend the Aurignacian phase to the Nile valley region as well. Solutrean sites are much fewer in number and are largely limited to Europe, except for the late Capsian sites of northern Africa. The Magdalenian phase, which ended the age of the late Paleolithic man, was even more widespread than the Aurignacian, extending into Switzerland, India, China, and Siberia. As might be expected, the representative artifacts of these several stages differed more or less from one region to another. Divergences from the typical European materials are mainly of technical significance, however, and may be safely ignored in the present brief survey. It is important to note that the dominion of late Paleolithic man was vastly more extensive than that of Neandertaloid man, even in Mousterian times. The culture of the period was the common possession of the mongoloid races in northern and central Asia, and of

the caucasoid races in southern Asia, northern Africa, and Europe. It was doubtless the heritage also of the more progressive negroid races of Africa which remained in the upper section of the country nearest to the caucasoids.

Before passing to the main discussion relating to the fossil and cultural record of Homo sapiens in Europe, the problem of late Paleolithic man in America must be briefly considered. It is now generally agreed that the aborigines of both of the Americas are the descendants of mongoloid migrants. These peoples probably reached the Alaskan peninsula from northeast Asia by means of the Behring Straits land bridge, or by boat along the island chain at this point. The degree of racial diversification among the Indians suggests that the first migrants must have arrived as early as the beginning of Upper Paleolithic times. The wide difference in cultural status between the Eskimo and plains Indians of the north, and the Pueblo, Aztec, and Maya tribes of the southerly region points in the same direction. If this interpretation of events be true, we should expect to find fossil and cultural remains of late Paleolithic man in America. A few ancient fossils have been found in association with such late Pleistocene fauna as the mastodon, bison, and ground sloth, but the indicated age of the human specimens has been generally discredited because of their similarity to modern types. Nevertheless, a considerable amount of circumstantial evidence for late Paleolithic man in America has accumulated. An ancient culture (47) of walrus ivory that has many points in common with the late Magdalenian and early Neolithic periods has recently been unearthed in Alaska. The finds include needles, awls, daggers, scrapers, axes, harpoons, female figurines, and the like, many of which are richly ornamented with animal and other carvings. The oldest of these ivory artifacts are the best and this may mean that the culture arose in Asia

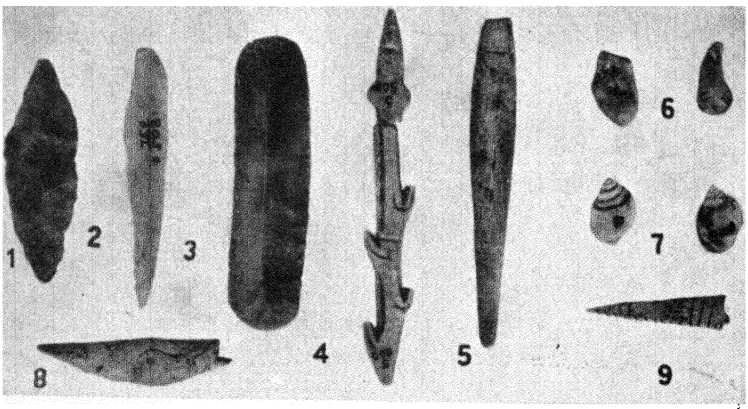


FIGURE 17. IMPLEMENTS AND ORNAMENTS TYPICAL OF LATE PALEOLITHIC AGE

(1) Knife blade or spear point of flint. (2) Knife or etching tool of flint (Aurignacian). (3) End scraper or planing tool of flint. (4) Harpoon point of bone. (5) Lance point of bone. (6) Beads or pendants of elk teeth. (7) Beads of univalve shells. (8) Fragment of bone with partial outline of a horse etched upon it (Magdalenian). (9) Fragment of bone with traces of geometric ornamentation. (From *American Museum of Natural History Leaflet*, No. 52. Fifth Edition, 1929, by Osborn.)

and degenerated when brought to America. At any rate, it affords good evidence that the mongoloids had arrived in America by the close of late Paleolithic times. If we suppose a succession of migratory waves of different racial composition from this time forward, all the known facts regarding the human occupancy of America can be accounted for. Nevertheless, man may have reached the New World much earlier, and, if so, the archeological evidence may be forthcoming at any time.

The stone-craft of the Aurignacian invader of Europe was essentially different from that of his Mousterian predecessor, although both made use of the flake primarily in the construction of implements. Aurignacian man knew how to prepare the flint nodule in such a manner that he could strike off long blade-like flakes, thinner and more regular in outline than those of the preceding age. The blade and the graver, examples of which are shown in Figure 17, comprise the typical implements of the period. These occur in a wide variety of sizes and shapes, along with numerous kinds of small implements such as scrapers, scratchers, points, and awl-like microliths made from slender chips and used for perforating. As a rule, the edges of Aurignacian tools were retouched on one or both faces. The point type was sometimes notched out at the base in stem-like fashion as if for hafting. In general, the Aurignacian implements continued to be used throughout Upper Paleolithic times, although they were modified considerably during the Solutrean and Magdalenian periods. Those of the latter period in particular are inferior both in quality of material and in workmanship. This was due, in a large part at least, to the gradual replacement of stone by bone, ivory, and reindeer horn in tool construction at this time. The highest and most refined type of Paleolithic stone-craft is exemplified in the laurel-leaf and willow-leaf points of the Solutrean period. These

were finely retouched all over by a special method of pressure flaking so that the body was made thin. The willow-leaf pattern often carried a lateral notch at the base for hafting. This special phase of Solutrean flint work appears to be more or less unrelated to Upper Paleolithic stone-craft as a whole. This fact and the limited distribution of the culture suggest that the Solutreans were probably an alien race whose supremacy in Europe was of short duration.

The development of a secondary culture of bone, ivory, and reindeer horn constituted the most notable advance in the industrial arts during Upper Paleolithic times. This began when man found that he could make new and superior implements from these materials by means of the stone tools then at his command. The general development in this direction is indicated in the table of Figure 15, in which the more important constructions are listed. Many of the artifacts which we have placed under the bone and reindeer industries were also made from ivory, secured from the tusks of the mammoth, and some of them from stag horn. The dart-head and javelin point of bone, and the dart-thrower and javelin shaft of reindeer horn came in relatively early and gave man a new advantage in the chase. Such instruments were constructed with patient care, and were often ornamented after the manner of the dart-thrower illustrated in Figure 18. A javelin point of bone and one of the several types of harpoon are shown in Figure 17. The harpoon was used primarily in spearing fishes, and could be drawn back, and thus preserved, by an attached cord of some sort. The bone needle and the buttons and toggles suggest that late Paleolithic man was able to make clothing with some regard for fit and convenience. The better type of needle was polished between smooth stones, and this may have been true of certain other bone artifacts as well. The microlith,

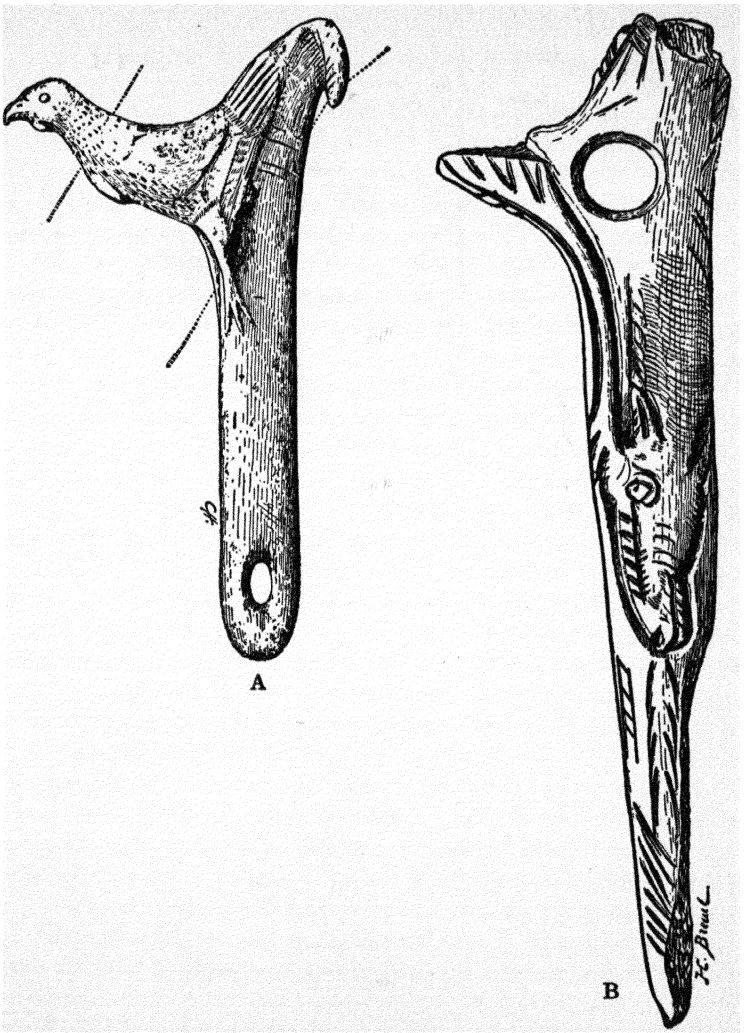


FIGURE 18. MAGDALENIAN REINDEER-HORN INDUSTRY

A. Dart thrower of grouse design (reconstructed portions outside dotted lines) from Mas d' Azil, France.

B. "Bâton de Commandement" with figure of reindeer. The hole was probably used as a gauge for javelin shafts.

(Scale: ca. ⅜ for both figures.) (From Luquet after Breuil.) (From Luquet, G. H., "Art and Religion of Fossil Man." English translation by Russell, J. T. Yale University Press, 1930.)

or some other sharp flint tool was used in making the eye of the needle, and in perforating buttons, and the shells, teeth, fish vertebrae, and the like employed in the manufacture of pendants, bracelets, and necklaces. Necklaces made up of as many as three rows of objects have been recovered from the late Magdalenian period. No one knows what purpose the "baton," which was usually made of reindeer horn and highly ornamented, actually served. The perforated type, illustrated in Figure 18, may have been used as a gauge for javelin shafts, or as a shaft straightener, but there is no clear evidence of this. Some authorities regard the "baton" as the wand of a magician, others as the scepter of a mighty chieftain. The height of the new bone, ivory, and reindeer horn culture came during the Magdalenian period as indicated by the relative abundance of specimens and the superior quality of the workmanship.

A high degree of skill was manifested by late Paleolithic man not only along industrial lines but in the field of the fine arts as well. The art impulse probably arose in connection with the decoration of implements and other personal belongings, especially those constructed of bone, ivory, and horn. The dart-thrower and "baton" of Figure 18 are good examples of this industrial, or portable art in which carving and engraving predominated. Painting was chiefly associated with the mural frescoes of the caverns and rock shelters, and these together with a few bas-reliefs done in clay on the cavern floors comprise the parietal, or stationary art of the times. The stone graver and scratcher were the primary tools employed in sculpturing and engraving. Pigments for painting were made by mixing powdered metallic ochres of different colors with grease. Sesqui-oxide of iron and oxide of manganese, from which the pigments could be made, are readily obtainable in nature and are insoluble in water. Stone mortars, bivalve shells, and bone tubes, were employed as

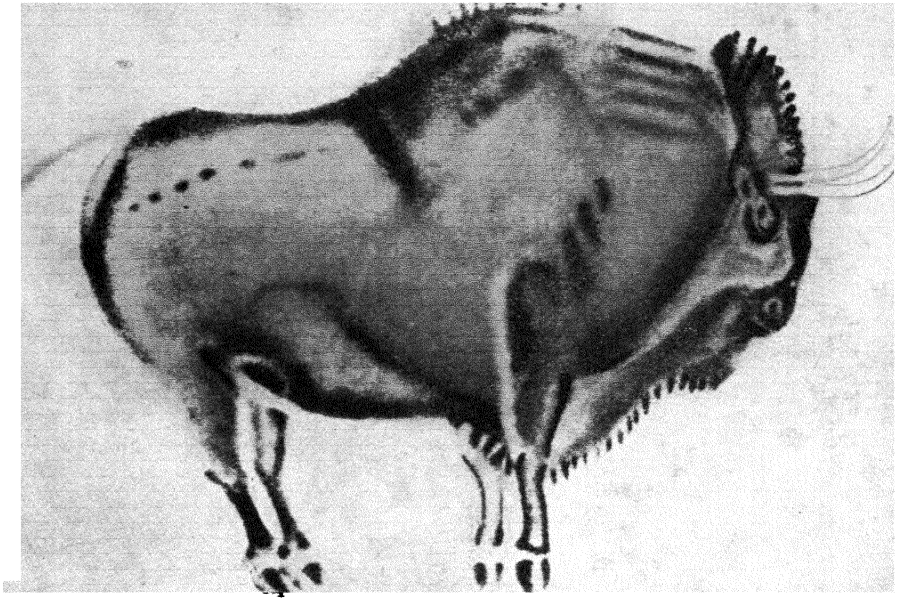


FIGURE 19. BISON IN FRESCO: CEILING OF THE CAVERN OF ALTAMIRA, SPAIN

The long, slender, sharp horns of the extinct European bison are faithfully portrayed. In this, one of the finest examples of Paleolithic polychrome art, four shades of color (black, red, brown, yellow) are used. Length from front to hips, 1.50 meters (5 feet). From MacCurdy, after Cartailhac and Breuil. (From MacCurdy, George G., "Human Origins: A Manual of Prehistory," 2 Vols. D. Appleton & Company, 1924.)

containers, and in one instance at least a stone palette covered with mixed paints has been found. Pigment crayons have also been discovered showing that the painting was not always done with a brush. The bison of Figure 19 is regarded as one of the best polychrome paintings of the late Magdalenian period, at which time the art of painting reached its highest perfection. Much of this mural art appears far back in the dark and secluded recesses of caverns, and must have required the use of the stone lamp of the period. The outline of the figure was cut into the wall by means of the graver, and detail and relief were secured by the application of various colors. The mural can be traced from the simple monochrome of Aurignacian times, in which merely the incised outline was painted black or red, to the finely modelled polychrome of Magdalenian times.

The art of late Paleolithic man, whether of the portable or the stationary sort, was essentially realistic in execution. The primary aim was to copy rather than merely to represent the object. This distinguishes it clearly from the art of the child or that of modern primitive peoples, as MacCurdy has pointed out. The art of the period was rather narrowly limited to the practical life activities of the Paleolithic hunter. This is shown by the predominance of the horse, reindeer, and other common game animals as subjects both in engravings and paintings. The landscape motive was entirely absent and little attention was given to inanimate objects, plants, and invertebrates, while fishes and birds fared somewhat better. The human form appeared mainly in sculpture, the female figurine with primary and secondary sexual characteristics greatly exaggerated, occurring most frequently. The strong undercurrent of realism is indicated by the complete absence of mythological creatures and animal forms with mixed attributes. In general, the profile rather than the front view

was portrayed, although the front view of the animal head, with body in profile, is shown in a few carvings. A good example of the latter appears on the "baton" illustrated in Figure 18. The general preference for the profile, and the poor quality of the front view when it was attempted, suggest that the Paleolithic artist did not understand the principles of perspective. The murals often depict the animal form in such wise as to give the appearance of active attitudes and movements. This would seem to be very remarkable in view of the fact that many of these had to be painted from memory. Single figures are characteristic of the period as a whole, although a few examples of composition picturing herd life have been found. The relation of the art of the times to the superstitious beliefs and magical practices of Upper Paleolithic man will be discussed in a later connection.

The fossil record shows clearly that Europe was invaded during this period by several more or less distinct races of Homo sapiens. The most outstanding of these by far was the Cro-Magnon type which will be described in some detail in the following paragraph. This type belonged to the white race, arrived in Europe during the latter part of the Aurignacian epoch, and is thought to have been responsible for the art which reached its height during the Magdalenian age. The importance of Cro-Magnon man is so great that the type is sometimes referred to as Aurignacian man, or even identified with late Paleolithic man as a whole. There is good reason to believe, however, that the early Aurignacian invaders of Europe include not only caucasoids from southwest Asia and northern Africa but also negroid stocks from the latter region as well. The negroids are represented by the Grimaldi race, fossils of which were discovered in a cavern of like name situated in Italy near the French frontier. This race was evidently not much over five feet in stature, with slender skeletal

parts, rather pronounced prognathism, and slightly receding chin. The skulls recovered were markedly dolichocranial, and the flattened nose along with the other features just mentioned, mark the race as definitely negroid. Fossils of the Grimaldi race have been found at only one place up to the present, and this suggests a restricted African invasion of short duration. That this race was among the early arrivals is shown by the fact that the fossils were found in the lower layers of the site, beneath the remains of another type of Aurignacian man. Numerous skeletal remains of the early caucasoid migrants have been found in various parts of Europe. They seem to have been a tall race like later Cro-Magnon man and similar to this type in general features. The same may be said of the Solutreans and other still later Asiatic migrants. In general, late Paleolithic man, whether caucasoid or negroid in race, possessed a large and well-developed brain and a strong and vigorous body.

Although reaching Europe somewhat late, the Cro-Magnon stock represents the most distinctive and modern type of late Paleolithic man. The race was tall in stature, averaging something like six feet in height, with some of the males running well over six feet four inches. The limb bones were straight and the posture as erect as that of man to-day. The skull was only slightly dolichocranial, like that of certain modern long-headed races, as contrasted with the markedly dolichocranial skull of the Grimaldi race and of still more ancient man. The absence of heavy brow ridges, and the presence of a high forehead and well-developed chin indicate something of the advance of this new type over Neandertaloid man. The face was broader in proportion to the cranium than is the rule among modern European races. The lower jaw was also somewhat more massive as may be seen from the reconstruction of the head of the Old Man of Cro-Magnon in the Frontispiece.

The cranial capacity averaged about 1600 cubic centimeters and hence equaled that of present-day dolichocephalic races. The brain was modern in every respect, the frontal region being large and well-elaborated as in later man. According to MacCurdy, the Cro-Magnon race did not differ in physical features to any marked degree from the rather long-headed Neolithic races which superseded them. The Neolithic peoples were the forerunners of the Europeans of historic times. They were chiefly Asiatics of the caucasoid type who brought with them the culture of a pastoral and agricultural life and conquered the nomadic Cro-Magnon race. The latter stock was not exterminated entirely it seems, but their dominion was destroyed, and the survivors absorbed by the Neolithic races. In certain parts of Europe to-day may be found peoples showing traces of the distinctive facial characteristics of this superior type of late Paleolithic man.

Our knowledge of the life and times of man during this period is fairly satisfactory, although incomplete in many ways. We know that the invader took over the caves of Mousterian man and used them for shelter during the long cold period when the Würm glaciation was at its height. This is clear from the fact that his fossil and cultural remains are often found superimposed upon those of the cave-man of the preceding age. Certain tectiform drawings seem to indicate that tent-like huts were constructed of poles and animal skins to serve as dwelling places as the climate became more temperate. Fire was used throughout the period for warmth and cooking, the large hearth in front of the cave entrance, with a pile of animal bones to one side, being the typical thing. The presence of the stone lamp indicates that fire was also employed to illuminate the cave during the Magdalenian phase at least. Pyrites and flints suitable for striking a light, some of which had evidently been employed in this

manner, have also been found. It seems likely, therefore, that the art of making fire at will has been known to man from Aurignacian times onward. Probably most of the clothing of this epoch was made from animal skins. Sewing was practiced throughout the period, as indicated by the presence of the bone needle, and buttons and toggles came in as early as the opening of the Magdalenian phase. Personal ornamentation by simple means of painting or tattooing the body was common. Jewelry such as pendants, wristlets, necklaces, and belts, made of bone, teeth, shells, and the like became more artistic as the period advanced.

Hunting and fishing were the chief pursuits of late Paleolithic man. His highest skill both as mechanic and artist was lavished upon the things that pertained to gaming activities of one sort or another. His diet was in no sense restricted, although the horse, reindeer, and other common mammals of the time were especially preferred. These were captured and brought home to the cave or other dwelling place, probably roasted, and became the occasion for a community feast. Some of the hearths of the time were extremely large, the one at Solutré in southern France measuring about thirty feet in one dimension and more than twice that in the other. Near this particular hearth a mass of animal bones has been found which included the remains of more than one hundred thousand horses alone. The reindeer, bison, cave-bear, and mammoth were also represented. Some of the bones were charred which suggests that the animals had been roasted. This site was occupied by man throughout the period and the magma of bones represents the accumulations of thousands of years. The horse, which evidently furnished the choice steak for the people of this region, was quite similar in type to the small wild horse of the Gobi desert to-day.

Although the Paleolithic hunter and fisherman led a

nomadic life, he probably lived for long periods of time within a relatively restricted region. He may have made use of the simple pointed log in navigating streams, but for the most part he moved from place to place on foot. In general, his life activities centered about the caves and rock shelters which furnished him a more or less permanent home. The facts cited above show clearly that large groups lived together in such places under some sort of community regulations. What these were we have no way of knowing. Very likely there was no such thing as private ownership, but there may have been restricted group ownership of fine implements and the fruit of the chase, associated with a particular dwelling place. Division of labor had probably been carried much farther than obtained in Mousterian times. Perhaps there were artisans representing stone-craft and the bone and horn industries, and artists of several kinds, as well as hunters and warriors. That warfare was common enough can hardly be doubted in view of the shifting of dominance among the various racial groups from time to time, not to mention the earlier extermination of the Mousterians by the first invaders. The dart and javelin were doubtless as useful in human warfare as in the chase. Moreover, in one instance at least, a javelin point has been found lodged in the vertebral column of a human fossil. Nothing is known of the family life of the times. It seems doubtful, however, if anything like monogamy had yet been thought of, in view of the wide prevalence of communal group life.

The superstitious beliefs and practices of late Paleolithic man are clearly reflected in all phases of his art. In spite of the realism of his sculpture and painting, it served primarily as an expression of the symbolism of magic, the artistic motive being definitely secondary. This is indicated by the fact that the best murals are usually found far back in the dark recesses of the caverns and could not

have been intended to beautify his dwelling place. The female type of such game animals as were highly prized and difficult to capture predominate both in his portable and stationary creations. Moreover, the cave-bear and other dread beasts of prey were sometimes portrayed with humanly inflicted mortal wounds. All of this points to the existence of a magic cult of the chase. The fecundity of the game animal was evidently to be secured by artistic representation, and the destruction of the ferocious enemy in a like manner. The dart-thrower on which a reindeer had been carved supposedly brought luck to the hunter in bringing down this choice game animal. The javelin shaft, which must be left smooth, acquired magic potency merely by being passed through the hole of the perforated "baton." For all we know, prayers and incantations may have been associated with the secluded murals of the caverns. The importance of the sex factor in the magical practices of the times is shown in many ways. The general preference for the female figure in both animal and human art is significant in this connection. In the human figurines in particular, the primary and secondary sexual characteristics were usually much exaggerated and the head, face, and extremities received scant attention. In a few instances, the human sex organs appear independent of the body and, in such cases at least, they may be regarded as phallic symbols. The dotted circle, which is generally recognised as a symbol of the sun, occurs in the Magdalenian phase. This suggests that the magical beliefs of the time may have been merely a part of a larger system of sun worship. In any case, it is clear that these early Europeans were impressed by the mystery of life and reproduction, and that this element played a major rôle in their magical art.

The artist and magician of the times was doubtless also the priest and performed the ceremonial rites associated with the burial of the dead. As we have seen, even

Mousterian man laid away his dead with votive offerings of one sort or another. This practice was greatly extended during the present period. Not only food for sustenance, but also richly carved weapons and implements of the chase for use in the happy hunting grounds were now placed with the dead. Pendants, strings of beads, necklaces, and the like are also commonly found with fossil remains of the period. We have no hint of the ceremonialism connected with the burial itself, but it seems likely that certain rites were performed. The practice of painting the corpse, and of burying paint with it was fairly prevalent. In some cases the arms were folded over the heart and the lower limbs flexed. On the whole, it appears that late Paleolithic man thought of life after death as a continuance of the present mode of existence. However, the votive offerings may have been intended for use merely during the journey to the land beyond. That the Paleolithic hunter possessed a highly developed imagination there can be no doubt. Much less is known, however, concerning his intellectual status. His language center and frontal lobes were highly elaborated, and his art suggests the possible use of a primitive written language. Certain alphabetiform characters engraved on bone and horn, from the Magdalenian phase, are regarded by some as the characters of a primitive written language. The claim is even made by the French archeologist, Piette, that the Magdalenians possessed two systems of writing, the one being hieroglyphic and the other cursive. As is well known, the hieroglyph is developed from pictorial art by a reduction of detail along conventional lines. Moreover, it is true that the spirit of realism in Paleolithic art was being superseded by symbolic representation as the period drew to a close. But the evidence at hand does not seem to warrant the definite assertion that written language was first devised by the Paleolithic artist and magician.

Neolithic Man

The passing of the Cro-Magnon dominion and the ushering in of the new age of Neolithic man in Europe took place gradually and was due to a number of circumstances. In the first place, the climate of central Europe became too warm for the reindeer, as the great Würm glacier retreated northward, which caused them to migrate into the Baltic region. This movement was delayed to some extent by the three minor ice advances of the Post-Glacial period—the Bühl, Gschnitz, and Daun—which still held the Alps and the Scandinavian peninsula in an arctic climate. Nevertheless, it is certain that the red deer had supplanted the reindeer in southern and central Europe by the middle of the Post-Glacial period, or approximately 15,000 years ago. Many of the Cro-Magnon peoples of the Magdalenian or Reindeer Age followed the reindeer into northern Eurasia. Apparently they left their artistry behind, since the traces of their culture which have been found in the Baltic region are more or less typical except in this respect. Perhaps they were driven to a more practical mode of life by the struggle for existence in the new territory. What ultimately became of these migrants we do not know, but it seems likely that they were absorbed by the Neolithic peoples who later settled in the north. The Cro-Magnon skull was long and narrow while the face was decidedly broad—hence they are classed as disharmonic dolichocephalics. The type reappears occasionally among Neolithic fossil remains in southern and central Europe as well as in these northerly regions. Moreover, certain existing peoples in various localities within these territories possess features which suggest that they derive in part from the old Cro-Magnon stock. It is generally supposed, therefore, that the survivors were gradually assimilated by the Neolithic peoples with whom they came in contact from time

to time. At any rate, we know that their dominion was gradually weakened by migrations to the north and by various other influences, and that they were finally displaced by new invaders coming from the south and east.

The stage of transition between late Paleolithic and full Neolithic culture is usually recognised as a distinct period and termed the Mesolithic, as shown in Figure 12. For the sake of greater unity, however, we have included this brief period under the Neolithic, making it one of the main stages of the latter. The age of Neolithic man, as thus defined, began about 25,000 to 30,000 years ago and ended with the Bronze culture which marked the dawn of ancient civilisation. The problem as to where Neolithic culture was first developed is still unsettled. It seems likely that it was either in central or southwest Asia, although it may have been in northern Africa. The present evidence points to the Iranian plateau in southwest Asia, the remnants of Neolithic culture in this region dating back to about 20,000 B.C. But even this seems to have been transplanted from an eastern source—probably from some section of central Asia. The latter region, where we would naturally expect to find the earliest cultural advance, has not been sufficiently explored as yet to warrant a definite statement on this point. Wherever it may have originated, Neolithic culture was carried from southwest Asia down into the Mediterranean region of Africa very early, but did not reach Europe until something like 15,000 years ago. The late arrival of Neolithic man in Europe is not surprising in view of the fact that this region is more or less isolated, and is also far removed from the center of dispersion. The chief lines of communication in ancient times led from Africa into Spain over the Gibraltar land bridge, or into Italy by way of Sicily. The land bridge at the Dardanelles offered a more direct route into Greece and eastern Europe to the peoples of southwest

Asia. A still more northerly route passed westward along the upper border of the Caspian and Black Seas and through the Caucasus Mountains. The direct road from central Asia led along the southern shore of the Baltic Sea. The Alpine and Scandinavian ice advances probably made the last two lines of migration impassible during the early part of the Post-Glacial age. The movement of Neolithic peoples into western Europe was thus restricted for a long period. This explains why late Paleolithic man remained undisturbed in this region for thousands of years after the development of Neolithic culture in Asia and Africa.

The first Neolithic invaders of western Europe probably entered Spain and Italy directly from corresponding parts of northern Africa. Some of them may have come also from earlier Neolithic settlements in eastern Europe. In any event, these migrants belonged to the Mediterranean race which, as Sergi has shown, had long since taken possession of the great Mediterranean basin. They were shorter in stature than the Cro-Magnon race which they found in power, but like them were dolichocephalic. However, their faces were narrow and long in conformity with their long heads, and hence they are classed as harmonic dolichocephalics. They contrasted sharply in facial features, therefore, with the broad-faced Cro-Magnons. Their descendants may be found to-day in Spain, Italy, Sicily, and in many other parts of southern Europe. The early Mediterraneans pushed northward from Spain into France, Germany, England, and finally into Scandinavia. As we find them in England they are known as the "long barrow" people from the fact that they built their barrows, or burial chambers long, instead of round as did the later Bronze Age races. The skeletal remains discovered in the shell heaps at Mugem, Portugal, and in a cave at Ofnet, Bavaria show a preponderance of this racial type during the Azilian-Tardenoisian period. They seem to have re-

tained the advantage of the pioneer colonist during the Neolithic stage proper as well.

Although the Mediterranean race was generally dominant throughout Europe during Neolithic times, the Alpine stock made its appearance very early at scattered points. This type is brachycephalic, or round-headed, and came into Europe from Asia, occupying for the most part the mountainous regions. A few brachycranial skulls were found both at Ofnet and at Mugem, which seems to indicate that the Alpines had reached these widely separated points during the transitional period. Crania of the same general type, belonging to this early period, were discovered also at Grenelle, France, and at Furfooz, Belgium. A little later we find this race dominant among the early lake-dwellers of Switzerland, although Mediterraneans and Nordics are also represented from time to time in the shifting population of this region. The Nordics appear for the first time near the close of the Neolithic among these lake-dwelling peoples. They were tall in stature and of the long-faced dolichocephalic type, and were presumably fair skinned even at this time. It seems altogether likely that they migrated from central or northern Asia originally. Such a type appears frequently in the Neolithic tumuli, or burial chambers of Poland and southwest Russia. The inhabitants of northern Russia in early historic times were also tall and long-headed. Whatever their origin, we know that they pushed into the Baltic region and finally settled in northern Germany and Scandinavia. They were doubtless the chief peoples of the Neolithic Age proper in Scandinavia. But the Mediterranean and Alpine races were both represented, and one or the other of these was probably responsible for the still older Maglemosean culture of Denmark. No one knows how early the three great caucasoid races—Mediterranean, Alpine, and Nordic—had become differentiated into clearly distinguishable

types. There is good reason to believe, however, that this had taken place long before the great Neolithic migrations began. A more detailed description of these racial types will be given in the following chapter.

In the European chronology, two main stages of Neolithic culture may be recognised, the transitional and the Neolithic proper. The first of these comprises the Azilian and the Tardenoisian sub-stages, while the Neolithic proper is usually divided into several sub-stages. The Maglemosean culture of Denmark is regarded as being roughly equivalent to the Azilian-Tardenoisian of lower Europe, although it comes considerably later in time. The Azilian-Tardenoisian sequence was well distributed throughout Europe, and traces of one or both sub-stages have been found in northern Africa, and in India and other parts of Asia. On the whole, this transitional stage seems to have been somewhat more extensive than the immediately preceding Magdalenian. The Neolithic stage proper became practically world-wide eventually, except for a few backward communities which have held tenaciously to certain elements at least of the Old Stone Age culture. We find remnants of a typical Neolithic culture even in the New World, among the more progressive Indian tribes of Mexico, Panama, and Peru. Whether the Neolithic stage in America dates back beyond the beginning of the Christian era still remains to be settled. If not, then it must be regarded as very recent, since the Neolithic age was reached, even in outlying Scandinavia, by about 7000 B.C. The walrus ivory culture of Alaska (47) is regarded by some as representing a Neolithic stage in which ivory had been substituted for stone. We do not know as yet how much of the culture of the Indian tribes was brought with them from Asia when they migrated to America and how much of it was developed independently later. The domesticated dog, bow and arrow, pottery, and certain other

widespread traits were likely imported. However, much of the culture of the Mayans, Aztecs, Incas, and other tribes must have been developed on American soil. Until more is known of the cultural status of the mongoloids when they migrated to America, no attempt can be made to correlate the chronology of the Old and New World.

As already noted, the period of transition to the Neolithic proper in Europe includes the Azilian and Tardenoisian sub-stages, named after their respective type-stations. In general, the culture of the transitional period presents a curious mixture of elements drawn from the Magdalenian industry, and from the newer sources. The stone implements were generally small and of the flaked variety. Blades were struck from the core in such wise as to require no retouching of the edge. Scrapers, scratchers, and pebbles that could be used as chisels or knives appear in abundance in transitional deposits. Geometrical microliths with sharp points are also common, some of these being mounted to the edges of the bone harpoon to serve as barbs. The harpoon was made of stag horn as a rule and the base was sometimes perforated. The workmanship was crude, and the animal ornamentation of its reindeer horn prototype was altogether lacking. Strangely enough, the bone needle and the bone javelin and dart-heads of the previous epoch do not appear in transitional deposits. The early Neolithic invaders were not actively artistic. Many pebbles, painted with red orchre set in grease, occur in Azilian sites but these do not seem to be related in any way to the art of Cro-Magnon man. The markings are alphabetiform in character and may have represented the beginnings of a crude written language. They are so regarded by Piette, who thinks that twelve of the symbols were handed down through Phœnician and archaic Greek to the alphabet of the classical languages of Greece and Rome.

Although the kitchen middens reached their height during the Neolithic stage proper, many of them represent a transitional culture. The shell heaps at Mugem, Portugal, on the island of Zealand, Denmark, and others along the coast of France may be included among these. The kitchen midden consists of a vast accumulation of the shells of the oyster, cockle, periwinkle, and other invertebrates at points along the shore where these organisms were captured and eaten by Neolithic man. The bones of fishes, birds, and mammals also occur in these community refuse heaps, but only in small quantities as a rule. These kitchen middens indicate clearly that early Neolithic man looked to the sea for much of his food supply. In coastal regions at least the chase became definitely secondary. The shell heap at Mugem, Portugal, represents an Azilian culture. The middens of Denmark comprise the Maglemose culture, which covers the entire transitional period. We find here a stone, bone, and stag horn industry, which in its later stages, was somewhat more advanced than the Tardenoisian generally. A new core implement, the pointed-polled stone axe, first appears in late Maglemose deposits. Bone fish hooks and stone knife blades as well as stag horn sockets for flint axes are also found. Crude pottery was made near the close of the epoch and this probably represents the beginnings of the ceramic art among European peoples. Pottery occurs much earlier, of course, in the more advanced cultures of southwest Asia and related regions. There is good reason to believe that the dog—perhaps for long a mere camp scavenger—was domesticated before the close of the Maglemose age in the north. Drawings of the bow and arrow appear from Azilian times onward, hence this implement must have been in general use.

The use of polished stone implements was once considered to be the distinguishing mark of the Neolithic stage

proper. It is now known, however, that chipped stone tools continued to be employed throughout this period. Polishing was first applied to the edge of the implement, and only near the close of the epoch do we find the entire surface ground in the case of the better and more highly prized tools. The axe and pick were the primary stone tools of the period, although numerous types made from the flake were common enough. The stone-craft of the time is illustrated in Figure 20, the perforated and completely ground axe of the series representing about the highest achievement in this line. The mining of flint of superior quality for use in making implements became widespread during this period. The better type of stone axe could be employed efficiently in felling a tree and in the construction of dugouts for navigation and of huts for shelter. The arrow-heads, spear-heads, daggers, and other stone weapons were often of fine workmanship. New implements of bone, stag horn, and wood were devised, but these cannot be described in detail. Ornaments were made from stone, clay, amber, jade, animal and human teeth, and perhaps from gold as well. Copper tools, made from native metal, appeared in restricted regions as the Neolithic Age drew to a close. The earliest dugouts were probably merely logs hollowed out by means of the stone axe and fire, but the art of shaping the small boat was far advanced before the close of Neolithic times. Boats of this type are limited to short distance navigation, but large rafts may well have been used for longer distances. The wheel was known before the close of Neolithic times but its development had not been carried far. The first wheels were merely narrow sections cut from the trunk of a tree, with a hole in the center for the axle. The chariot with metal tire wheels did not appear until the Bronze Age was well under way.

The general advance which distinguished the Neolithic stage proper centered about the following important lines

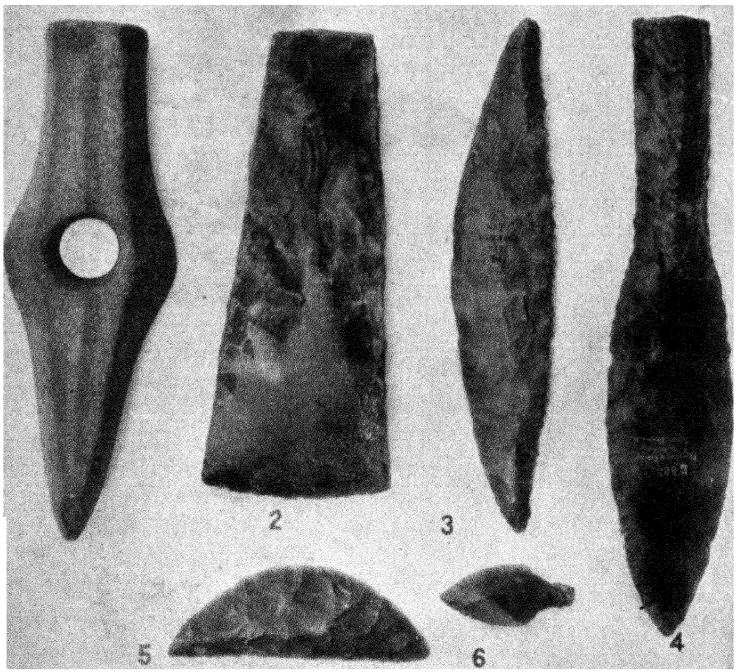


FIGURE 20. IMPLEMENTS TYPICAL OF THE NEOLITHIC AGE

(1) Ax-hammer of stone, perforated for hafting. (2) Ax of flint, partly polished. (3) Saw of flint, one edge notched. (4) Dagger of flint, probably in imitation of metallic form. (5) Knife or sickle blade of flint. (6) Arrow point of flint, also made in larger sizes and used as spear point. (From *American Museum of Natural History Leaflet,* No. 52. Fifth Edition, 1929, by Osborn.)

of industry: pottery making, agriculture, weaving of textiles, and the domestication of animals. In general, these arts are not European in origin, but were brought to this region from time to time by groups of migrants coming from the older cultural centers of Asia. The best pottery of the period was not only well shaped but ornamented in various ways. The cord design, made by drawing a cord tightly around the vessel before baking, and the banded design as well spread over a wide territory. The potter's wheel was not known in Europe until after the beginning of the Iron Age. Agriculture was carried farthest among the Swiss lake-dwellers who cultivated wheat, barley, millet, lentils, and the like for both human and animal consumption. According to MacCurdy, milling stones occur in abundance in the Neolithic sites of this region. Dried fruits, such as apples and pears, were stored by these people for winter use. The cherry, plum, wild grape, strawberry, raspberry, blackberry, and many other fruits were in common use, but most of these were probably gathered wild. Flax was cultivated for the fibre, and the remnants of the weaver's art from this period are varied and of superb workmanship. The textile art included knitting, spinning, and the construction of fishing nets and baskets, as well as hand and loom weaving. Apparently wool was not used very extensively as yet. A reconstruction of a Neolithic loom, many specimens of which have been discovered, is shown in Figure 21. As we have seen, the dog was the earliest animal to be domesticated, being used by early Neolithic man in the chase and to protect his dwelling place. The cat is seldom if ever found in Neolithic sites in Europe. The domestication of animals for food and hides probably preceded the development of agriculture and made the latter necessary. Cattle, swine, sheep, and goats were the principal herd animals to be domesticated by Neolithic man. Agriculture and the

domestic herd were important elements of the culture complex of the lake-dwelling peoples during the latter part of the period.

The dwellings of Neolithic man varied considerably in type from place to place. In northern Europe, where

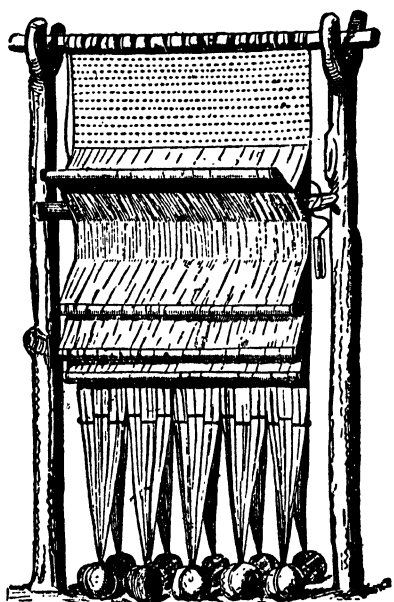


FIGURE 21. RECONSTRUCTION OF A NEOLITHIC LOOM

On a simple loom of this type M. Paur found it possible to make a great variety of excellent designs with ease. From MacCurdy after Keller. (MacCurdy, George G., "Human Origins," 2 Vols. D. Appleton & Company, 1926.)

hunting was still widely practiced, the small pit-dwellings were generally prevalent. The pit was usually circular in form, rarely more than seven or eight feet in diameter, and something like four or five feet in depth. The cone-shaped superstructure was made of poles and branches of trees and plastered with a thick coating of clay or covered

with animal skins. These cave-like homes, with a hearth in the center, must have been inconvenient because of their small size, but they offered the necessary protection against the cold climate of the north. They were grouped together in villages as a rule, and in some cases there was a central "manor house," presumably for the chieftain. The central cellar at Stutzheim was quite large, being somewhat more than thirty feet long and ten feet wide. The log house, built wholly above ground, did not make its appearance in the north until about the beginning of the Bronze Age. The pile-villages of Switzerland represent the best dwelling places of Neolithic man in the European region. The entire village was built upon a huge platform which extended out over the lake. The platform was supported by long piles, sharpened either with an axe or by charring, and driven into the bed of the lake. More than 100,000 piles were used in some cases, and these were sometimes ballasted by a mass of rock, transported thither by boat. The walls of the houses were made of poles set upright, the place of junction being filled with clay, moss, and the like. The roof was thatched with straw or reeds. The houses were rectangular, sometimes as large as 22 by 27 feet, and usually contained several rooms. The village included stalls for cattle in winter and granaries and other storehouses as well as general workshops. The remains of several hundred of these pile-villages have been found along the lake shores of Switzerland, Austria, and southern Germany.

The highest architectural skill of Neolithic man was expressed in the erection of various sorts of megalithic monuments, such as dolmens, menhirs, cromlechs, and alignments. The dolmens were rudely built stone tombs for family or community use before the age of individual graves came in. They ranged in complexity from the simple type illustrated in Figure 22, to the giant dolmens

with many chambers and a passageway. These tombs were protected by a mound of stones and earth, known as a tumulus or barrow, and this was sometimes flanked by a row of stones. The dolmen cult probably spread into Europe from Asia or Africa about the middle of the Neolithic Age in this region. There are nearly 5,000 of these ancient tombs still existing in France alone, and they are especially numerous also in Denmark. The dolmens of Europe generally are similar in most respects to the more ancient types of Asia and Africa. The menhir consists of a single large unworked stone set up on end after the manner of a monument. A wide variation in height occurs among the many thousand menhirs still scattered throughout Europe. The giant menhir at Locmariaquer, France, weighed more than 300 tons, and stood nearly 70 feet high before it fell. The cromlech and alignment were derived from the menhir, according to MacCurdy. The former is a circular, oval, or rectangular arrangement of menhirs, while the latter involves their placement in parallel rows. The celebrated Stonehenge monument of Britain illustrated in Figure 23, is a cromlech of very complex arrangement. The menhir, cromlech, and alignment do not seem to be related in any way to the dolmen or burial chamber, and the purpose which they originally served remains a mystery. The menhir may have been

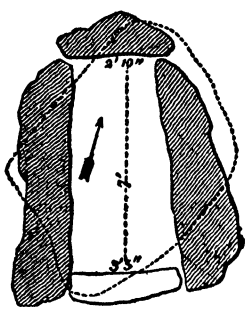


FIGURE 22. Ground Plan of Small Dolmen at Vollerup, Moen Island, Denmark. This is the simplest type of dolmen or funerary chamber; it characterises an early phase of the third epoch of the Neolithic period in Scandinavia. The structure consists of four stones for the walls and one for the roof. From MacCurdy after Müller. (From MacCurdy, George G., "Human Origins," 2 Vols. D. Appleton & Company, 1926.)

erected, as MacCurdy suggests, as a cenotaph to a fallen hero, or as an historical monument of some sort. The cromlech and the alignment might have been associated with sun worship or with the ritual of the earth cult, for all we know. Many of the immense stones utilized in the construction of megalithic monuments were evidently transported quite a distance. How this was accomplished

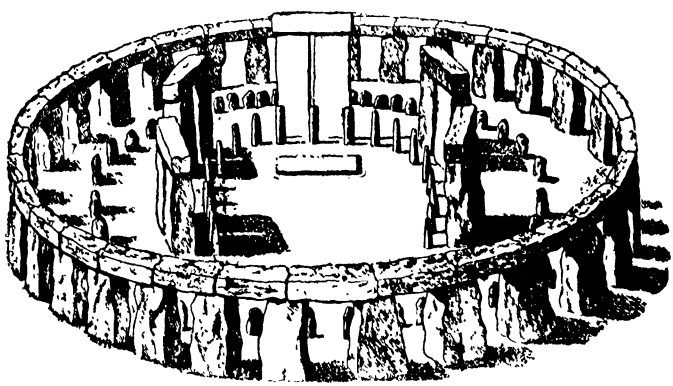


FIGURE 23.

STONEHENGE, ON SALISBURY PLAIN, ENGLAND (restored)

The outer circle of stones had a diameter of approximately 98 feet and stood about 13 feet high. The 5 giant triliths within, consisting of 2 uprights and a cross piece, ranged in height from 19 to 26 feet. The "altar stone" lies within the inner circle in front of the trilith in the background. A line drawn through the "altar stone," a second stone within, and a third without the main circle is said to point approximately in the direction of the rising sun at the summer solstice. From Wilder after Browne. (From Wilder, H. H., "Man's Prehistoric Past." The Macmillan Company, 1924.)

and how the larger stones were raised to the upright position offers another puzzling problem.

Our knowledge of the social and religious life of Neolithic man is incomplete and unsatisfactory as yet. Something of his religious beliefs may be inferred from his burial customs. Doubtless he laid away his dead with elaborate

ritual in the dolmens which had been so laboriously constructed. The prevalence of superstitious practices may be taken for granted, and cults of various sorts were likely the order of the day. Pendants of stone, clay, and amber axes suggest that there may have been a cult of the axe. Circular pieces of bone removed in the trephining of the skull were perforated and worn as amulets. This surgical operation itself may have been intended to release demons, presumed to be responsible for epileptic and other strange seizures. As Tyler (50) suggests, an agricultural cult may have existed centering around the "goddess-mother" of life. Some form of sun worship certainly prevailed and this may have been associated with the cromlech and other of the megalithic monuments. As a matter of fact, we know very little of the gods which Neolithic man worshipped or of the devils which he feared, but we may be certain that both were legion. If he had been more of an artist he might have left us better clues as to his religious and social background. As it was, his main interests were those of a farmer and a builder. While he fortified his villages there is no reason to suppose that he was an aggressive warrior. As Tyler has remarked, the cult of the war gods came into Europe later with the great migrations of the Bronze and Iron Ages. Barter in amber, jade, and the like existed, and the commerce between the groups was probably more extensive than is commonly supposed. The development of the village community throughout Europe at this time shows that some sort of loose tribal life had been established. The building of the great megalithic monuments required skilled leadership and social coöperation of a high order. Whether a matriarchial form of tribal life prevailed, as Tyler has suggested, we do not know. There is no reason to suppose that the social structure was the same among groups differing so widely in ethnic and cultural background.

The Dawn of Civilisation

The distinctive type of culture which deserves to be regarded as a genuine civilisation must be based primarily upon the use of metals. In spite of the great advance of Neolithic man in the practical arts, his culture at its highest was essentially of the simple rural sort. The fact that his implements were mainly of stone, stag horn, and wood meant a definite limitation upon the possibility of further progress. The marks of a true civilisation are the building of great cities and the extension of commerce by land and sea. These developments could not be brought about until metals should come into general use. The basis of modern civilisation was laid, therefore, during the sequence of metal ages in which bronze and iron played the major rôles. The first metal to be employed by man in an important way was copper. This often occurs in the native state and requires merely to be molded or hammered into the desired form. Copper was worked in this simple fashion in Egypt and southwest Asia as early as 5000 B.C. A limited use of native copper was made also by certain of the Neolithic peoples of Europe as the age was drawing to a close in this western region. But copper is soft and requires the use of tin or some other hardening alloy in order to be of much value in industry. By some happy accident it was discovered that the addition of a small proportion of tin to molten copper produced bronze, which possesses marked advantages in the construction of tools and weapons. This was the beginning of the art of metallurgy, involving smelting, casting, forging, and the use of various alloys, which ushered in the metal ages.

The Bronze and Iron cultures, like the Stone cultures which preceded them, were developed elsewhere and imported into western Europe. The Bronze Age began in Egypt and southwest Asia about 4000 B.C. or, perhaps,

even somewhat earlier. The new culture spread slowly westward, reaching the Greek peninsula around 3000 B.C. and the island of Crete, where the Bronze Age is known as the Myceneæn, a few centuries later. It was carried into western Europe by peoples migrating from the East, and by traders, from about 1900 B.C. and onward. Iron was known in Egypt almost as early as was bronze, but it was not employed very extensively for a millennium or so. The Iron Age in western Europe began about 900 B.C. and lasted until the beginning of the Christian era. We do not know when bronze was first used by the Mayas, Incas, and other progressive Indian tribes of the New World. It must have been much later than in Europe, however, and may have represented an entirely independent American development. None of the aborigines of the New World advanced to the Iron Age previous to the coming of Columbus at least (51). The metal ages are sometimes referred to as proto-historic since they comprise the period of transition from prehistoric to historic times. In point of fact, however, there is a considerable overlapping between the metal ages and the early historic period. The latter is being extended farther and farther back into the metal ages, as these are usually defined, as the ability to decipher the inscriptions of these ancient peoples increases from time to time.

The diffusion of the new Bronze culture into Europe from the East took place gradually and without bringing about a sharp break with the older Neolithic mode of life. The better type of stone implements continued to be used for centuries, and some of the later ground stone axes were patterned after the new bronze type. One of the most important accomplishments of the period was the casting of bronze, although hammering was not dispensed with entirely thereafter. Stone molds have been discovered for the casting of axes, saws, and the like. The bronze axe

in a variety of shapes was apparently the principal tool, but knives, razors, sickles, and numerous other implements were made of bronze. The sword first appears as a pointed dagger without sharp edges, but the double-edged long sword was later developed. The bronze helmet came in at about the same time, evidently as a means of protection against the long cutting sword. The dagger was sometimes hafted thus forming a halberd, and employed in warfare along with the sword and spear. The horse was domesticated and used as a mount and trained to pull the chariot which man had devised. The ox became the common pack and draft animal and the "hoe culture" of Neolithic man was displaced by the rude wooden plow. Navigation of rivers, lakes, and the quieter seas was made possible by the development of ships of larger type. Barter was encouraged by the devising of weights and measures and by the invention of money, metal rings being first employed as such. Traffic in copper ingots, tin, amber, salt, and many other commodities was widespread. That some attention was paid to music is indicated by the occurrence of bronze trumpets of elaborate design. Notable advances were made in the ceramic art and in the textile industry. Thus we see that the culture complex of the Bronze Age was much broader and richer than that of Neolithic times.

The new Iron culture which had reached southeast Europe by this time spread to the north and west slowly, in spite of the cheapness of the metal and its obvious advantages in the construction of sharp tools. Within a few centuries, however, it had been substituted for bronze to a considerable extent and new uses had also been found for it. Only wrought iron was available as yet, since the art of casting iron was not developed until the Middle Ages. The first scissors known to Europe were made of iron and were very similar in construction to the sheep

shears of to-day. The bronze sword was gradually replaced by a larger and heavier one of iron. Knives, razors, sickles, scythes, and many other cutting tools were also made of the new metal. It is interesting to note that the pocket knife, with iron blade and bone handle, made its appearance in the Hallstatt, or earlier stage of the Iron Age. The anvil, hammer, plow, lock and key, and numerous other iron implements were devised before the close of the period. Bronze was employed in making scabbards, helmets, shields, and the like as well as retaining many of its old uses. The potter's wheel appeared in western Europe near the close of the epoch giving a new impetus to the ceramic art. Glass was also known but it was moulded rather than blown into shape. The chariot was highly valued and was often buried with the body of the owner after the manner of the ship burials of the later Vikings. The larger citadels of the time were fortified by immense ramparts of earth and masonry and war and carnage became more and more the sport of mighty leaders.

Much of the religious and social life of Neolithic man persisted into the metal ages, although new elements also made their appearance. The dolmen continued to be used for burial in certain communities, although inhumation in flat graves occurred in places, and incineration was widely practised at times. The sun worship of Neolithic man was greatly elaborated by his descendants. The sun was now associated in a symbolic manner with the chariot and the ship, both of which are represented in the art of the times as the vehicles of the sun in its daily journey from east to west. The cult of the axe persisted, and many new cults arose out of the richer life of the times. That the art of the medicine man flourished is shown by the occurrence of their kits in caches and tombs. Doubtless many of the gods and goddesses of Greece and Rome had

also come to be feared and worshipped before the close of the Iron Age.

The ethnic background of western Europe was not basically altered by the migrations which took place during the metal ages. The country was well populated by this time with Mediterraneans, Alpines, and Nordics and no new ethnic elements were introduced. In general, the regional distribution of the three caucasoid races remained the same, although numerous minor movements and shifts occurred. As we have seen, the Mediterranean race had swept over western Europe during early Neolithic times, but had established themselves firmly only in the southern portion of this area. The Nordics had taken possession of Scandinavia, and the Baltic region generally, long before the beginning of the Bronze Age. The Alpine peoples had settled in the mountainous region from which their name is derived, during early Neolithic times, and had since moved westward toward the coast. When the metal ages opened, therefore, the brachycephalic Alpines formed a wedge between the long-headed Mediterraneans to the south and the long-headed Nordics to the north. The Alpines were the leading agriculturalists of the time and, during the metal ages, they extended themselves in both directions at the expense of the two neighboring races. This trend not only persisted into early historic times but still continues. It illustrates very well the advantages of the process of infiltration and absorption over that of invasion by force, so characteristic of the other two races.

The early Nordics stand out as a restless and warlike race, spreading their power abroad for a time at least by endless conquest. It seems likely that they had reached Italy from the valley of the Danube by 1100 B.C. and the Greek peninsula somewhat earlier. It is claimed by some authorities that they played a leading rôle in the political developments of both of these countries. However, we

know that Greece and Rome were predominantly Mediterranean and their culture came from the east and not from the valley of the Danube, or from the shores of the Baltic. The maximum extension of the Nordics in Europe coincided approximately with the beginning of the Iron Age in this region. Although their language, the Indo-European, was spread abroad by their conquests, they did not influence greatly the ethnic composition of any but the northern coastal countries. Roughly speaking, the Iron Age in Europe covered the millennium just preceding the beginning of the Christian era. This was the age of Homer, of the Greek supremacy and decline, and of the Roman republic. Before the close of the Age, the imperial Roman legion had planted itself securely in western Europe and the isolation of this region was forever ended. Several important overland trade routes had been opened up during the Bronze Age, and commerce by sea had entered upon a more extensive phase about the same time. The new metal cultures were spread throughout Europe by the trader, who left no impress upon the ethnic composition of the country, no less than by new groups of migrants coming from the more easterly centers of caucasoid population.

Chapter VI

RACE AND CIVILISATION

It should be clear from the foregoing account that the racial diversification of modern man had taken place long before the beginning of historic times. Perhaps we should recall the main series of events which led thereto in order to be able to place contemporary racial groups in their proper temporal perspective. As we have noted, all existing peoples belong to the sapiens branch of the human stem. This large-brained species became distinct from other species of the genus Homo about the middle of the Pleistocene epoch, or perhaps even earlier. The human stock at this time—certainly no less than a half million years ago—was a generalised and plastic type capable of further specialisation in detail in several directions. Modern man at that remote period was neither negroid, mongoloid, nor caucasoid, but possessed a complex of more or less neutral characteristics in so far as present races are concerned. It is obvious that the basic similarities of contemporary races can be traced back to this remote common ancestry. Such differences as now exist between them were brought about by the later evolution of various groups along distinctive lines under divergent conditions of life. The first and most important stage of raciation was brought about by the primary migrations of peoples from the common center of dispersion in central Asia or elsewhere. These peoples became diversified into the three great racial stocks—negroid, mongoloid, and cau-

casoid—in the general regions indicated on the map of Figure 16. Secondary migrations from new centers of evolution in each of these broad regions led in time to the division of the great racial stocks into more or less distinct races. As an example of the latter we may cite the breaking up of the caucasoid stock into the four principal white races: Hindu, Mediterranean, Alpine, and Nordic. This stage of raciation was followed by a tertiary phase in which types, still more local, arose either from regional isolation or from extensive racial mixing. In general, the primary and secondary migrations took place before the close of the Pleistocene epoch, while the tertiary phase has been in process since the beginning of Neolithic times at least.

It is important to note that the evolution of races within the human species has proceeded along the same general lines that determine raciation in plants and animals. The races of man do not vary any more among themselves than do the races of many animal species existing in a state of nature. The range of variation in man is much less, of course, than in the dog, but selective breeding under domestication has been an important factor in inducing variability of type in the latter case. Migrations, geographical isolation of strains, and prolonged inbreeding are the chief influences making for racial diversification under natural conditions. Migrations are obviously highly selective, regardless of whether the total population of a region or merely a part of it be included. Such movements often entail severe physical hardships which continue until the survivors have become acclimated to the new habitat. Inbreeding over a long period of time tends to accentuate and perfect the type which natural selection has thus preserved. In early times, geographical isolation was often effected by mountain chains and large rivers, since man had not yet developed the simplest means of communication. The conditions existing at the time

the primary and secondary migrations took place were thus highly favorable to the evolution of races. Whether mutants appeared in the human line at this time to become the nuclei of new races we do not know. At any rate, the condition of group segregation which then existed would have favored the preservation of mutants from being swamped by outbreeding, once they occurred. The crossing of races that had already become well established probably led to the formation of new races during the tertiary stage of the process. It is well known that when two fairly large racial groups become thoroughly intermixed by long interbreeding, they are likely to constitute a new racial type distinct from either of the original strains. This sometimes happens by a gradual infiltration of the two races in adjoining regions but, as a rule, it results from the absorption of a subject people by a conquering race.

The origin of contemporary races can thus be accounted for in a general way by the application of well-established evolutionary principles. If we turn analytical, however, and seek to determine the precise factors underlying specific racial characteristics we encounter insuperable difficulties. No one knows, for example, the genuine cause of differences in skin color between the great racial stocks. The old notion that the dark skin of the negroid races evolved as a necessary protection from the scorching sun of equatorial Africa has long since been abandoned. Nor is it any more reasonable to suppose that the extremely fair skin of the Nordic type was bleached by the cold and foggy climate of the Baltic region. Such notions rest upon the doctrine of acquired somatic characters which modern biology disallows, in the absence of convincing evidence. One possible explanation of the color factor is that the common ancestor of the modern races still possessed the heavily pigmented skin of his anthropoid forbears. In such a case, the skin color of the mongoloid and

caucasoid races might conceivably be due to a reduction of pigment in these stocks after the negroid races had dispersed abroad.

But even this explanation still leaves us with the basic problem as to the nature of the mechanism underlying the change. Did the loss come about gradually or was it the result of a sudden mutation? How does it happen that the skin of the caucasoid is less pigmented than that of the mongoloid? Was there a series of mutations involving skin color in the case of the caucasoids? Similar questions might be raised concerning differences in shape of head, thickness of lip, and many other of the more obvious racial characteristics. But all such questions of detail are to no purpose, at least for the present. Much the same situation obtains with respect to the specific characters of animal races and varieties. No one has yet offered a satisfactory explanation of the origin of the short legs of the dachshund or the stubby snout of the bull dog. We know that the production of both human and animal types depends upon selective breeding of some sort. But the genetic mechanisms directly responsible for the origin of specific features in either case are not well understood as yet. We should be on our guard, therefore, against the acceptance of easy and simple explanations in this field.

Similar caution should be observed with respect to all theories which seek to account for the distinctive characters of races by appealing to specific physiological factors. A good example of this type of explanation is furnished by what may be termed endocrine theories of racial evolution. The theory tentatively offered by Sir Arthur Keith represents, perhaps, the most ambitious attempt of this sort. This eminent authority seeks to account for the evolution of the great racial stocks on the assumption that each represents a glandular constitution of a distinctive type. The proposed theory is little more than an

analogy based upon the pathological effects of sub-normal glandular functioning on the development of bodily form in the white man. Thyroid deficiency, as Keith points out, leads to arrested development of the basal portion of the skull and results in a bulging forehead, and a flattened face with deficient nasal skeleton. These characteristics are distinctive of the mongoloid face and to a lesser extent of the negroid face. If we take the white man as a standard, the mongoloid might then be regarded as distinctly sub-thyroid and the negroid as moderately so. Both racial stocks would appear to be sub-pituitary also, since they lack the prominent eyebrow ridges and chin and the bodily bulk and stature of the white man. Their pigmentation indicates, moreover, that they are sub-adrenal because it is known that a lessened activity of the adrenals in the white man leads to the yellow-brown skin associated with Addison's disease. Finally, both races are more or less sub-interstitial as indicated by such eunochoid characters as slight beard, scant bodily hair, and the like. The heavy beard and relatively profuse bodily hair of the caucasoid male are known to be due to the activity of the interstitial glands of the gonads, from the time of puberty onward. The normal white stock possesses, apparently, a perfect endocrine balance and hence is physiologically superior to the other two stocks.

If this theory rested upon a basis of fact, then it should prove to be a welcome source of comfort to those who fear for the continued supremacy of the white races. However, no evidence has been brought forward in support of the theory, although certain of its basic assumptions could be subjected to empirical tests. It might readily be ascertained, for example, whether or not the negroid and mongoloid races are actually deficient in glandular constitution, as the theory supposes. If this could be shown, the meaning of the fact for racial evolution could then be de-

termined by an analysis of the conditions which might have led to the segregation of peoples on the basis of glandular constitution in the remote past. But nothing in the way of empirical verification of the hypothesis has been attempted up to the present. Such evidence as we possess seems to show that there is no significant correlation between race and glandular type. Certain strains occur in each of the racial stocks which exhibit glandular deficiencies and, so far as known, in about the same proportion. Nor is there any reason to suppose that the normal glandular constitution of one race differs profoundly from that of another. In fact, we find short and tall people, and a wide variety of facial physiognomy within each of the great racial stocks. No part of the theory seems more fanciful and absurd than the assumption that negroids and mongoloids possess eunochoid propensities. For it is well known that these two stocks include the most vigorous and prolific of contemporary races. Furthermore, the theory is not in accord with certain facts relating to the modification of structural characters in radical race mixtures. As suggested by Gates (72), the whole complex of characters associated with the endocrine deficiency of the racial type should be modified together in the hybrid. This would follow from the fact that the influence of an endocrine secretion within the body is more or less general. Contrary to Keith's theory, however, bodily complexes appear to be broken up into unit characters in racial crossing, just as in the crossing of strains within the same race Finally, even if racial stock and glandular type were highly correlated, this would not mean that the endocrine constitution of the caucasoid was necessarily the superior one. Pathological effects follow from hyper-functioning as well as from the deficient functioning of glands. The problem of the best balanced glandular type for ultimate survival would still remain to be settled.

As a matter of fact, there is no good reason to suppose that any single specific factor has played a dominant rôle in racial evolution. The breaking up of a species into divergent strains, or varieties, is a slow process in which many and various factors are always involved. Migrations, wars, marriage customs, changing economic conditions, and a thousand other things operate directly or indirectly to influence the germinal background of the human group. Natural selection, here as elsewhere, includes all those factors which serve to change the germinal trend of the group either immediately or in the long run. Such factors vary not only in kind but in relative importance from time to time and from group to group. Speculation as to the specific causes of racial evolution is more or less futile until more is known of the actual conditions which existed in the past. Something of the general course of events is reflected in the various groups of mankind that have survived to the present. We may turn our attention, therefore, to contemporary races with the aim of determining the kind and amount of diversification that has taken place. In the following section the problem of the classification and regional distribution of existing peoples will be discussed. From then onward, our primary interest will be in the comparison of racial stocks and of races along biological, psychological, and cultural lines.

Contemporary Races

It is hardly necessary to remark that the concept of race derives its essential meaning from its biological and evolutionary connections. As we have seen, the great racial stocks represent branches of the stem of modern man which have diverged in different directions. Moreover, each of these stocks has given off lesser branches which together comprise a group of related races. Some of these races

have become further separated into fairly distinct varieties or sub-races, but we shall disregard these smaller divisions in the present treatment. It is obvious that racial relationships imply varying degrees of genetic kinship. This point is of considerable importance because of the constant danger of confusing race with such cultural factors as language, religion, and political affiliations. Inaccurate statements reflecting this confusion of thought are often found, even in scientific writings. The term "Jewish race," for example, is applied to all those who hold the Jewish religion, although the group so designated includes peoples belonging to several races. In like manner, the "French race" is applied to all those who live in France and speak the French language, in spite of the fact that all three of the caucasoid races are thus included. Race is a matter of genetic origins and blood kinship. The people of a given race may, and often do, change their language, religion, or political affiliations without affecting in the least their racial character. On the other hand, the racial background may be changed by intermarriage with other races, while the language, religion, and political factors remain unchanged. In brief, race and culture are distinctive factors in human evolution and may vary independently from time to time.

The anthropologists have given considerable attention to the problem of arranging a natural classification of contemporary races. Such a grouping would necessarily reflect the varying degrees of genetic kinship that now obtain among existing peoples. The chief difficulty grows out of the fact that some of the modern races cannot be traced back as yet to the point where they branched off from the Homo sapiens stem. Even in other cases, certain of the linkages are more or less problematical. The whole matter is complicated by the fact that racial mixture on a large scale has been going on for thousands of

years. In Europe, for example, the three caucasoid races have been crossing more and more freely since the beginning of Neolithic times. It is extremely doubtful if anything like a pure Mediterranean, Alpine, or Nordic type can now be found, except perhaps in a few unusually sequestered regions. Long before this, the great racial stocks had been crossed rather extensively in southern Asia and in northern Africa. In some instances, the hybrid people then became relatively isolated and a new racial type was established by centuries of restricted interbreeding. Some of these hybrid groups involved the crossing of all three of the primary racial stocks—or at least so it seems from an analysis of their features. It is not always easy to determine the racial strains of a hybrid group that has once become homogeneous by long interbreeding. In fact, it is these radical mixtures, resulting from the crossing of the primary racial stocks in the remote past, that do not seem to fit well into a natural system of racial classification.

Numerous systems of classifications were formerly devised, based upon a single physical trait such as skin color, type of hair, cranial form, and the like. The tendency of late, however, has been to make use of a number of traits because no single feature seems to be clearly definitive in all cases. Some difference of opinion prevails among anthropologists as to which traits constitute the best criteria of race. The most important requirement in this connection is that a trait be stable in heredity from generation to generation. The distinction between external, or superficial traits which may be easily observed, and internal, or skeletal traits which must be measured, has been made by Dixon (56). He believes the latter are more dependable, and from among a large number of these he selects the following for use in classification: cranial or cephalic index, cranial length-height index, and nasal

index. However, it does not follow that such basic factors as skeletal form are superior to superficial features as racial criteria, simply because they are more fundamental to the organism. It often happens that superficial traits that possess no utility value to the species are extremely stable in heredity—most likely because of this fact. We have adopted the classification of Kroeber, as shown in the diagram of Figure 24, which is based upon a relatively large number of superficial and skeletal characteristics. This classification has the advantage over certain others of giving due prominence to the facts at hand regarding the evolution of races.

The three primary racial groups, represented by the large circles in Figure 24, may be thought of as being only distantly related to one another. These main groups arose from the primary migrations of the Homo sapiens stock from the center of dispersion—a separation that may have begun as early as a half million years ago. The small circles within each of the large circles represent the races that were formed by the secondary migrations, originating within the region occupied by the several primary stocks. The areas of overlapping indicate hybrid stocks that have become relatively homogeneous by long-continued interbreeding. More recent racial mixtures, in which the two strains have not as yet become uniformly diffused so as to form a new racial type, are not shown in the diagram. The small circles lying outside the large ones represent races of doubtful classification which arose from the crossing of two or more of the primary racial stocks. As we have noted, these radical crossings occurred at some very remote time in the past, and relatively homogeneous racial types have been brought about by continuous interbreeding. The Ainu of Japan appear to be a caucasoid-mongoloid cross, while the Polynesians seem to be largely Malaysian, or oceanic mongoloid, with an admixture of

both caucasoid and negroid blood. The native Australians are dominantly negroid but show certain caucasoid affinities. The Indo-Australians of India, Indo-China,

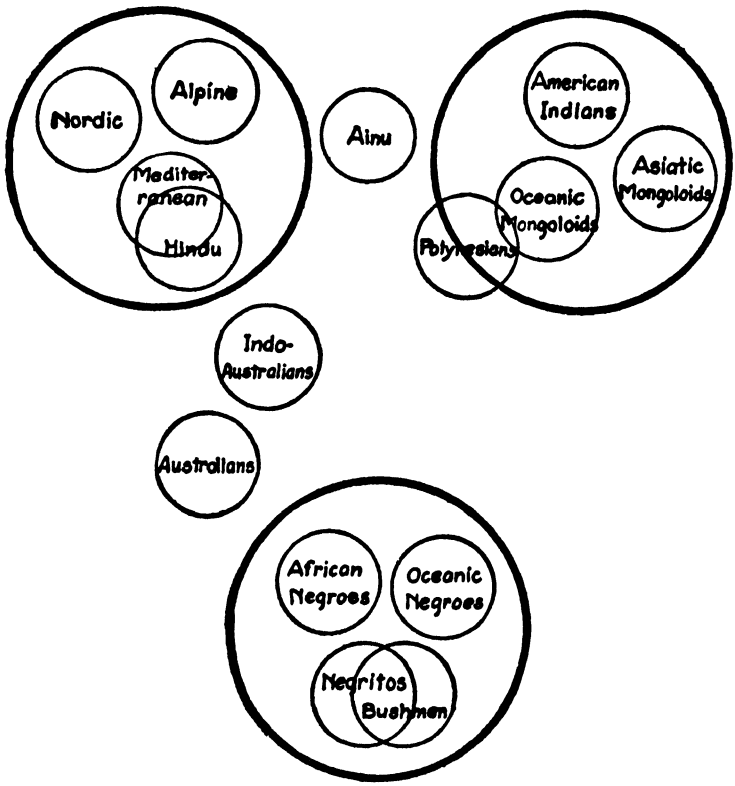


FIGURE 24. RELATIONSHIP OF THE HUMAN RACES
Distances between the centers of circles are indicative of the degree of similarity. The large circles represent the three great racial stocks: Caucasoid, Mongoloid, and Negroid. (After Kroeber.) (From Kroeber, A. L., "Anthropology." Harcourt, Brace and Company, Inc., 1923.)

and the East Indies are probably a mixture of a very early caucasoid type with Australoid or negroid stock. Kroeber maintains that each of these races of doubtful classifica-

tion is partly caucasoid, although the white stock in some cases may have been very primitive. It seems likely that these primary stock hybrids, or radical mixtures, are all very much older than any of the present caucasoid races of Europe.

While the races of doubtful classification are of special interest to the anthropologist because of their unique character, they may be safely ignored in making general racial comparisons. As Kroeber has pointed out, 99 per cent of all living individuals, and more than 90 per cent of all the tribes and nations of the earth belong to the three great racial groups. The geographical distribution of the three primary stocks, as it existed before the era of colonization began, is shown in the map of Figure 25. In order to simplify matters, the races of doubtful classification have been included in the stock with which they appear to affiliate most closely, in showing the world-wide distribution of races. Only one major change has since occurred—the extension of the caucasoid races over the two Americas. It will be seen that Europe, northern Africa, and western Asia are caucasoid. The Nordics, Alpines, and Mediterraneans occupy the northern, central, and southern portions of Europe, respectively, while the Hindus are restricted to India. At the close of the fifteenth century, the American Indians held the New World, but have been largely exterminated or absorbed since. The Asiatic mongoloids have long inhabited the greater part of Asia and the oceanic mongoloids, or Malaysians, much of the East Indies. If we omit the Negritos and Bushmen, the negroid stock comprises two races, the one occupying central and southern Africa and the other New Guinea and other islands of the Melanesian group. The Bushmen are found in South Africa, while the Negritos, or dwarf blacks are represented in equatorial Africa and in several of the islands of the East Indian Archipelago. For those who

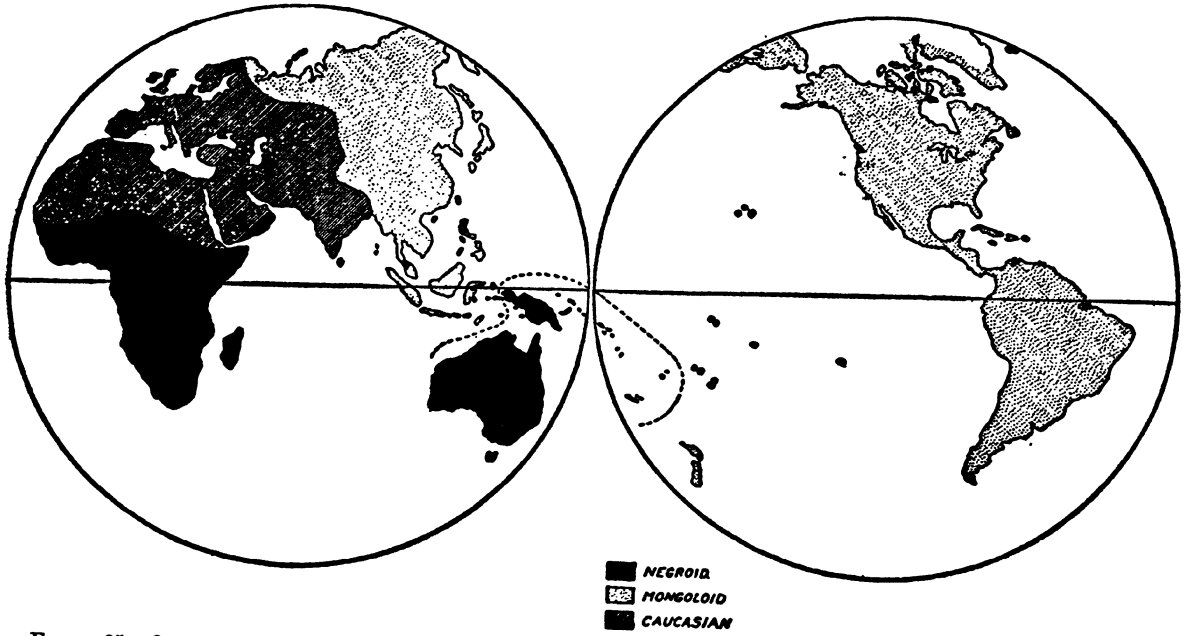


FIGURE 25. Outline distribution of the primary racial stocks of mankind according to the three-fold classification. The Australians, Ainu, Vedda, Polynesians, etc. are included in the stock with which they appear to affiliate most closely. A larger map with more shadings would be required to do even approximate justice to the intricacies of a complete race classification. The aborigines rather than the present populations are shown for the new world. (After Kroeber.) (From Kroeber, A. L., "Anthropology." Harcourt, Brace and Company, Inc.)

may wish to pursue the topic of racial distribution further, the recent volume by Havemeyer (61) on contemporary ethnography is recommended.

Racial Characteristics

At the present time racial distinctions are made primarily on the basis of such structural traits as follow racial lines and prove to be relatively stable in inheritance. This procedure would seem to be warranted by the fact that the more outstanding effects of racial diversification are structural in character. There is no good reason, to be sure, why functional traits should not be utilized in racial analysis, provided valid indices of such were available. Nothing of importance in the way of physiological measurements bearing upon the problem of racial differences has been forthcoming as yet. Numerous attempts have been made by the psychologist to compare racial groups in intelligence and other behavioral traits, but these have yielded no clear-cut results to date. As a rule, the differences in score are small in tests of this sort, while the likelihood is great that cultural as well as racial factors are involved. Even if these results are accepted at their face value, they show for the most part merely slight quantitative differences between races rather than qualitative and discrete differences. Nor is there any reason to hope that psychology will be able to supply us with distinctive traits of any significance for racial analysis in the near future. It is not enough to secure measurable differences between well controlled racial groups; the functions tested must be shown to be stable factors in heredity. Very little is known at present regarding the inheritance of complex behavior capacities in man, and such knowledge is necessary before the psychologist can apply his results to racial problems. The work of the psychologist to date centers

casoid races vary in skin color from white to brownish-black and thus overlap the mongoloid and negroid races considerably in this respect. There is almost complete overlapping in hair color from group to group, except for the flaxen hair of the caucasoid Nordic type. In texture the hair of the caucasoid is fine and wavy; that of the mongoloid coarse and straight, while that of the negroid is medium and kinky or woolly. These differences in texture can be accounted for by the shape of the hair in cross-section and by the angle of the root of the hair in the skin. The negroid and mongoloid races usually have little hair on the face and body, whereas the caucasoids are distinguished by heavy beards and abundant body hair in general.

It is evident from this analysis that the three primary racial stocks can be readily distinguished on the basis of a number of physical traits. On the whole, the negroid seems to differ very markedly from the caucasoid and mongoloid, and probably represents a more primitive type. As we have already noted, there is reason to believe that the negroid stock separated from the common Homo sapiens stem earlier than the other two main stocks. It seems probable that the pigmentation of skin, hair, and eyes in man is an inheritance from his anthropoid ancestors. The reduction of pigmentation probably took place in the caucasoid and mongoloid stocks after the primary negroid migrations had taken place. The marked facial and alveolar prognathism of certain negroid races is also a primitive trait, and may be explained on the same principle. This characteristic becomes more and more prominent as we trace the human stem backward in time. The receding forehead and low broad nose of the typical negroid belongs likewise to the same general assemblage of primitive characteristics. The strong tendency to dolichocephalism in the negroid stock is also a primitive trait, although certainly less so than prognathism. The early species of the

genus Homo, as well as the still earlier generic types of man were all extremely long-headed. The early caucasoids and mongoloids were moderately dolichocephalic, and the same is also true of some of the contemporary races of these stocks. The brachycephalic, or broad-headed type seems to have made its appearance in the white and yellow stocks in connection with the secondary migrations of these peoples. It is clear that the evolutionary trend is from extreme long-headedness to moderate long-headedness and to broad-headedness. The brain of the negroid also shows primitive characteristics in being generally smaller and less richly convoluted than that of the caucasoid and mongoloid. This difference seems to be of more importance than the others mentioned, since it might mean a limitation upon the behavioral capacities of those negroid races in which the trait is found to be most marked. If the assumption be granted that the negroid stock migrated from the center of dispersion rather early, the analysis of the table becomes meaningful. The caucasoids and mongoloids are much alike because they evolved together for a time after the negroids had migrated.

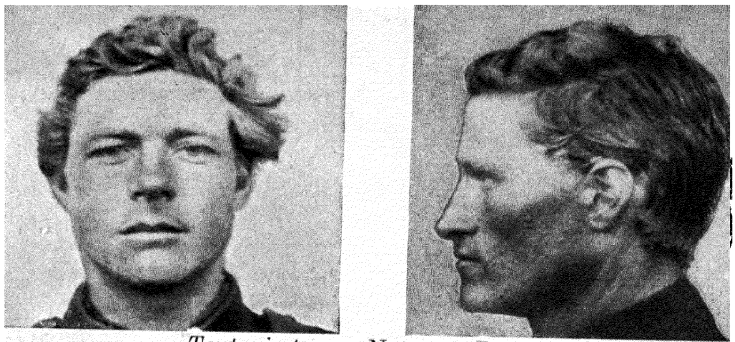
It should be borne in mind that the occurrence of primitive physical traits in a racial stock does not necessarily imply racial inferiority. As will be pointed out in the following chapter, certain of the evolutionary trends in man involve losses rather than gains. Many of the physical differences between races are obviously superficial in character and in themselves are of slight importance. Nevertheless, they do serve to distinguish racial groups on the basis of genetic background and hence are pertinent to our present inquiry. On the whole, these physical differences give us the most valuable evidence we possess regarding the divergent evolution of the primary racial stocks after their separation. What we find in each of the racial stocks is a retention of certain primitive characteristics

along with a high degree of specialisation in others. The caucasoid, for example, retained the hairiness of face and body characteristic of primitive man to a much greater extent than did the mongoloid and negroid. The short head hair of the typical negroid seems to mean a further loss which was not shared by the mongoloid. If we suppose the hair texture of the common ancestor of modern man to have been roundish, the woolly hair of the negroid may be considered as the most highly specialised in this respect. Perhaps the lips of this common ancestor were of medium thickness and not unlike those of the living caucasoid races. The thin, grayish lips of the mongoloid and the full, red, and somewhat everted lips of the negroid would then represent divergent lines of specialisation. The loss of the heavy eyebrow ridges of primitive man was carried further in the negroid and mongoloid races than in the caucasoid races. The extremely long fore-arms and lower limbs of certain of the taller negroid races probably represent fairly late and local specialisations. There is certainly no good reason to suppose that the common ancestor of modern man, or even the early negroid type, possessed arms and legs of more than average length.

The lines of cleavage become much less sharply defined when we pass from the primary racial stocks to the several component races. The secondary migrations, from which the races arose, came relatively late and hence we should not expect to find the differences between races very great. Many of the physical traits common to the group had become well established before the separation took place. The distinction between related races is based upon a small number of physical traits, and in most cases the differences are merely quantitative. It will be sufficient for our purposes to mention a few of the more important traits. The caucasoid races differ among themselves mainly in stature, cephalic index, and coloration of skin, eyes, and hair. The

Nordics are tall, the Alpines and Hindus are somewhat above the average, while the Mediterraneans are very near the general human average. All of the caucasoid races are long-headed except the brachycephalic Alpines. The Nordics have very light skin, blond hair, and blue eyes; the Alpines white skin and brown hair and eyes; the Mediterraneans darkish white skin and black hair and eyes, while the Hindus have brownish-white skin and black hair and eyes. The three European caucasoid types are shown in Figure 27. The mongoloid races exhibit fewer differences of importance among themselves. The Asiatic and Malaysian types are generally similar except for the "mongoloid" eye of the former, and the brown skin of the latter. The American Indian also has brown rather than yellow skin and is taller than the other two mongoloid races. In general, the mongoloids are brachycephalic, although some of the American Indian tribes are dolichocephalic. The African and oceanic, or Melanesian negroids differ mainly in stature, the former being tall and the latter medium. The Negritos, or dwarf blacks are very short in stature, broad-headed, and exhibit less prognathism than the other two negroid races.

It seems hardly necessary to remark that a race is never a homogeneous group. The descriptions we have given should thus be regarded as merely average or typical. A race usually includes a more or less dominant type and numerous sub-groups which are typical in one or more traits. The range of individual differences, even within racial sub-groups, is likely to be much larger than is ordinarily supposed. It is sometimes very difficult, on this account, to select the genuinely distinctive traits of a race for anthropological description. As a rule, the type so delineated is merely a sort of composite individual, built up by a subtle method of anthropometric averaging. The difficulty of dealing with racial types is greatly increased



Teutonic types. NORWAY. Pure blond.

Alpine type. AUSTRIAN. *Blue eyes, brown hair.*

Mediterranean type. PALERMO, Sicily. Pure brunet.

FIGURE 27. THE THREE EUROPEAN RACIAL TYPES

(After Ripley.) (From Ripley, W. Z., "The Races of Europe." D. Appleton & Company, 1899.)

by the intermixing of neighboring peoples. In fact, when such crossing occurs on an extensive scale, the distinctive traits of both races tend to disappear. On the whole, the peoples of Europe and America are hybrids and therefore belong to no particular race. They are caucasoids, however, since they represent a hybrid strain of two or more of the European white races as a rule.

Racial Superiority

The problem of racial superiority is extremely difficult to approach in a genuinely scientific spirit. Personal prejudices are likely to be a disturbing factor because of one's own racial affiliations. Interpretations of the few facts at hand are usually biased because of the social and political bearings of the question. Much of the difficulty, however, seems to be due to the lack of a clear understanding as to the proper basis of racial evaluation. Bits of structural and functional evidence are often thrown together with no regard for their real significance. The biological and cultural aspects of the question are seldom properly distinguished. As a result, confusion of issues and racial prejudice go hand in hand. If a rational approach to the matter is to be made, therefore, it is important first of all to establish a sound basis of evaluation. The first step in this direction may be taken by the elimination of all structural criteria of race from the argument. Physical traits are of first importance in determining racial relationships, but they tell us nothing of significance as to racial capacity and efficiency. Perhaps an exception should be made with respect to the size and convolutional elaboration of the brain, but even this point should not be taken for granted.

The evolutionary test of human worth in the group as well as in the individual is the capacity to survive in a high

state of cultural achievement. It is obviously ridiculous to suppose that such superficial traits as stature, facial profile, hair texture, skin color, and the like are of any intrinsic importance to group survival. It has recently been shown by Paterson (64) that stature, weight, cephalic index, and head size bear little or no relationship to mental efficiency as usually measured. The same thing seems to be true also for malnutrition, physical defects, and certain other conditions which are often regarded as especially detrimental to mental work. It may well be that a given race is constitutionally inferior to another, but the evidence for this must be furnished by the physiologist rather than by the anatomist. It cannot be assumed on *a priori* grounds or inferred directly from structural peculiarities. In like manner, the intelligence and behavioral capacities of the several races must be put to the functional test. In the last analysis, it is for the psychologist to say whether or not a race possesses the mental calibre and emotional stability to enable it to meet successfully the demands of modern civilisation.

If the first step in establishing a sound basis for racial evaluation is to restrict the evidence to functional capacities, the second step is to secure valid measures of the latter. This is a much more difficult task than is commonly supposed, as shown by the widespread acceptance of experimental findings uncritically. In order to be valid, the differences secured in the measurement of racial groups must be shown to be due to hereditary factors that are primarily racial in character. Both individual variations in heredity and environmental influences of every sort must be either eliminated or equated for the groups. The individual factor can be controlled fairly well by taking large samples of each racial group, selected in the same manner in each case. It is almost impossible, however, to eliminate wholly immediate and remote environmental

differences in the testing of races. Immediate environmental factors can be controlled reasonably well by testing all the racial groups to be compared, under the same general set of conditions. The remote environmental effects are not easy to control for the reason that these are likely to be inherent in the nature of the task to be performed. This fundamental difficulty is well illustrated in the tests ordinarily utilized to measure racial intelligence or some other aspect of behavior. As a rule, such tests have been devised to measure the reaction of the white man to his own particular cultural pattern. The several tasks required often reflect the remote environmental background of this single racial stock. Any other racial group is thus placed at a disadvantage because of lack of acquaintance with the terms, tasks, and procedures involved in the rating. This holds true to some extent even of performance tests in which neither the tasks nor the directions require the use of language. In fact, it may be safely said that no test has yet been devised for measuring complex behavioral capacities which can be regarded as wholly fair to all racial groups. These facts and principles should be kept in mind as we seek to interpret the more important contributions of physiology and psychology to the problem of racial evaluation.

The evidence from comparative physiology to date seems to show that no racial differences of consequence exist in the basic bodily activities. The normal temperature for all races is 98.6 degrees Fahrenheit, the pulse rate is approximately 70 beats per minute in the adult, and the respiration rate is about 18 per minute. Individuals within any racial group may vary considerably from these general norms, hence the differences between racial groups would need to be fairly large in order to be considered significant. The popular belief is that the negroid is especially adapted to a hot climate and the caucasoid to a temperate or cold

climate. The recent studies of Huntington (63) seem to show, however, that the best climate for human energy output is the same for all races. He finds the optimum climate to be one in which the average daily temperature is about 64 degrees Fahrenheit, with a diurnal fluctuation range between 55 and 70 degrees. The four types of blood groups, common to the great apes and man, are found in all the races, although the proportion of each differs somewhat from race to race. Differences in susceptibility to certain diseases seem to be regional rather than racial in most cases. The chief exception appears to be in instances where a new disease is introduced into a racial group. In such cases, the death rate of the latter is likely to be high for a few generations until a natural immunity has been built up. The general similarity in physiological processes among contemporary races probably means that the basic bodily activities were fixed in the common ancestral stock before the primary racial migrations began.

It is interesting to note in this connection, that most of the recent attempts to classify mankind on a basis of constitutional type cut squarely across racial lines. The most careful analysis of this sort has been made by Bean (52) who divides all mankind into three types. His two main types are the Hypermorph and the Mesomorph, and these are found in all of the primary racial stocks. The Hypermorph is tall in stature and relatively slender in all bodily proportions, while the Mesomorph is bulky in bodily build and medium to broad in general proportions. The two types are almost identical with the dolichocephalics and brachycephalics, since bodily form and head form tend to be harmonious in a general way. They correspond roughly also to the Linear, or thyroid type and the Lateral, or sub-thyroid type of Stockard (67). We are not especially interested in the question of the validity and usefulness of these and similar classifications of con-

stitutional types. Perhaps these opposite types merely represent the two extremes of a graduated series which includes all mankind. At any rate, these rough systems of grouping people should not be taken too seriously, since Paterson (64) finds little or no relationship between constitutional type and mental efficiency. The interesting point for us is that each of the primary racial stocks include both the Hypermorph and the Mesomorph. This shows that constitutional type is not a racial trait and argues for the essential similarity of primary racial stocks, in so far as endocrine factors are concerned. This would seem to be convincing evidence against the theory of Keith, mentioned above, in which endocrine factors are regarded as being primarily responsible for racial evolution.

No significant racial differences have been discovered as yet in sensory acuity, perception, or simple sensory-motor activities. This general field has not been systematically investigated but enough has been done to show that marked divergences do not exist. The old notion that primitive races possess keener sensibilities than the advanced races has now been discarded. Primitive and civilized peoples average about the same in sensory acuity in the field of vision, audition, smell, and touch. In certain tests, modern primitive peoples have seemed to react somewhat less quickly to pain stimulation, but this probably means merely that the sensitivity was not reported to the experimenter until genuine discomfort was felt. The color sense, according to Woodworth, is probably very much the same the world over. This authority found no important differences in speed of tapping among a wide selection of races from all three of the primary stocks. In the case of a simple form board test, the differences were relatively small as among Whites, Indians, Eskimos, Ainu, Filipinos, and Singhalese. The Negritos and African Pygmies scored low on this test, but Woodworth is

inclined to think this was due in part to the strangeness of the task. One must remember that cultural factors may be effective, either as aids or hindrances, even in such simple situations. The habits of perception and reaction derived from the cultural background are markedly different in primitive and civilised peoples. We are accustomed to observe things close at hand, whereas the environment of the savage is likely to put a premium on observation at a distance. Keenness of perception is known to be greatly increased in all the sensory fields by habit and training. Large individual differences in this general field occur within any racial group, and the differences between racial groups must be correspondingly large in order to be genuinely significant. All things considered, it seems safe to conclude that the sensory and motor capacities of man are essentially alike regardless of race. These simple behavioral patterns, like the basic physiological activities, were probably well established in Homo sapiens before the primary racial migrations took place.

It should be clear from the foregoing account that any possible racial evaluation must rest upon an analysis of the more complex intellectual and emotional capacities. It is in this general field, if at all, that differences of any magnitude would logically be expected to occur. Moreover, it is only differences of this sort which would likely prove to be of genuine importance in determining the cultural potentialities of a race. We have already pointed out certain fundamental difficulties involved in the measurement of the functional capacities of racial groups. In the last analysis, these come down to the inability to eliminate the factors of nurture and selection in the application of tests to divergent types. It is now generally recognised that all tests of intelligence, and of other behavioral capacities, are heavily weighted with nurtural factors. While they may reflect the relative native abilities of individuals

of the same cultural background, they do not measure accurately the innate capacities of groups taken from different cultural areas. Many of these tests are verbal in character and impose a serious language handicap on alien races. Most of them are speed tests, and operate to penalize races whose general habits of life are not keyed up to that of the urban white man. Klineberg found, for example, that American Indians tend to be very accurate in performance tests, but they work at a somewhat slower pace than the white man. It seems reasonable to suppose that the Indian would work as speedily as the white person if brought up under the conditions of our more complex civilisation. The problem of group selection is equally difficult to control in making racial comparisons. It is well known that educational and social opportunities are factors of importance in determining the test scores of groups within a given race. For this reason, it is necessary to compare racial groups of the same educational and social status if genuine racial differences are to be measured. But this is seldom possible because one racial stock is likely to be dominant over others, temporarily at least, in any political unit. This is well illustrated by the negro situation in the United States—there is no such thing as equal educational or social opportunity for the black man in America. It would be manifestly out of the question to secure comparable groups, in this sense, from Patagonia, Melanesia, and western Europe.

It must be confessed that no definite and certain evidence of racial differences in intelligence has been obtained up to the present. Psychological tests seem to show that the Chinese and Japanese, or Asiatic mongoloids, and the several caucasoid races possess about the same mental calibre. As might be expected, the Mediterranean, Alpine, and Nordic races are much alike in cultural background as well as in general level of intelligence. The

oceanic mongoloids and the present remnants of the aboriginal American tribes usually rate measurably lower than the caucasoids and Asiatic mongoloids in tests of intelligence. The negroid races rate much lower than either as a rule. It has generally been found that the mental test score of the hybrid is higher than that of the "lower" race represented, but lower than that of the "higher" race. The American mulatto rates higher than the pure negro, and the Indian-White hybrid of the United States and Mexico rates higher than the pure blood Indian of these regions. Reuter (75) and others seem to feel that this is due not so much to the white blood as to the superior social and economic opportunity of the hybrid stock. If taken at their face value, the results to date would seem to warrant the division of contemporary races into three or four groups with the caucasoids and Asiatic mongoloids at the top and the negroids at the bottom. The small and poorly convoluted brain and the low cultural status of the negroid peoples also point to a low rank for this stock. Nevertheless, it should be remembered that the factors of nurture and selection operate to the greatest disadvantage in the case of the "lower" races. It is worthy of note, also, that the tests that have been best controlled in these respects have yielded the lowest measures of apparent racial inferiority. This fact has led certain anthropologists to the hasty conclusion that if perfectly fair tests could be devised all racial differences in test scores would disappear. This does not seem at all likely, however, if such tests were made reasonably difficult as well as fair. The prejudice in favor of racial equality in intelligence is quite as obnoxious to the scientific mind as the prejudice against such equality.

Numerous factors, aside from average intelligence test scores, should be taken into account in dealing with the problem of racial superiority. The amount of overlapping in test scores from one racial group to another is important.

The less overlapping that occurs the more certain we may be that a genuine racial difference exists in the function measured. The upper limit of variability is also important since it shows the highest reaches of each racial group in intelligence as measured. The relative frequency with which individuals of superior ability occur in a racial stock may be of much more significance than the group average. For it is the superior individual that sets the pace, as a rule, in cultural advance, whereas the average man becomes merely a secondary limiting condition. It is well to remember, also, that genuine differences in the mental calibre of races may exist which are not brought out by any test of intelligence so far devised. It has sometimes been suggested that races differ more in temperament than in intelligence. Nothing definite can be said on this point at present since the psychologist has been unable to devise tests possessing any general validity in this field. A few racial comparisons have been made but, as Garth (57) has shown, these have revealed nothing of importance in the way of an analysis of the personality of racial types. Very little is known regarding the possibility of racial differences in the field of creative art and esthetic appreciation. It has been found that the young of all races agree pretty much in the matter of color preferences. Such preferences in the adult differ considerably from race to race but this appears to be due mainly to local tradition. Boas thinks it possible that such elementary esthetic forms as symmetry and rhythm are human rather than racial, although the specific art styles in which these forms are expressed grow out of the cultural background of the group. Much too little is known at present relative to the more intangible aspects of human personality to warrant an attempt at evaluation along racial lines.

Racial inferiority is sometimes directly inferred from the fact of low cultural status. The cultural history of

a people may be of some value in a general way in determining racial level. But it is necessary to bear in mind that race and culture are more or less distinct aspects of the life of a people. Race refers to biological and social potentialities, while culture or civilisation refers to the manner in which these may happen to be realised at a particular time. There is good reason to believe that a given race passes through a cycle of cultural evolution, and one would need to know the complete cycle before passing judgment on racial potency. Perhaps it is safe to say that the negroid races and a few others who have never advanced to a high state of culture are lower than those that have. But it is not impossible that some of these races will yet rise to a high cultural level and thus show that they have possessed innate potentialities all along. The history of the caucasoid and mongoloid races would seem to suggest due caution in drawing definite conclusions on this point. It is well known that the Nordics were very properly regarded as uncouth barbarians by the civilised Mediterraneans of Greece and Rome. A few centuries later, however, they had absorbed the culture of these older civilisations and in time became one of the dominant racial elements in western Europe. The Chinese and Japanese more recently have been able to shift from an older culture to a modern one of a radically different sort. It is not the relative cultural status at a given time that counts, so much as the cultural history taken as a whole.

Innate racial capacity is only one of the important factors which enters into the determination of cultural status. The material resources of the region in which a people dwell may influence cultural growth considerably. This is much less true to-day than formerly when the exchange of commodities was not so widespread. The importance of climate in cultural evolution has been stressed by Huntington (63). While he recognises the value of racial ca-

pacity and material resources, he believes that climatic conditions determine in large part the cultural trend of a people. The highest civilisations, so he thinks, have always been located in regions possessing a climate closely approximating the optimum for man. His researches seem to show that this optimum, regardless of race, is characterised by an average temperature of 64 degrees Fahrenheit with a diurnal range of from 55 to 70 degrees. Seasonal variations are also important, the most favorable conditions being frosty but not cold winters, and warm but not hot summers. This theory would lead us to expect that the highest civilisations, both past and present, arose in the temperate zones. As a matter of fact, however, Egypt, Babylonia, Greece, and Rome were all located in southern lands. Huntington disposes of this point by supposing that the climate of the northern hemisphere has grown appreciably warmer during historic times. By this he means to imply that the optimum temperature actually prevailed in these southern lands at the time the great civilisations were developed there. He substitutes for the traditional concept of the westward sweep of civilisation, the notion of a northward, or coldward trend. The peoples who migrated northward, regardless of racial type, have built up highly complex cultures. Perhaps this view represents an unwarranted emphasis upon the factor of climate, but certainly general environmental influences of this sort cannot be safely ignored. A number of other theories of cultural evolution in which environmental factors are stressed have been summarized in a recent volume by Thomas (68).

There seems to be a general agreement between the mental test ratings of races and their cultural level during the historic period. In both respects, the caucasoid races and the Asiatic mongoloids make much the best showing. If we take into account the ancient civilisations of America

and the place of the Indian in modern Mexico and South America, the western mongoloids would appear to come next. The oceanic mongoloids, or Malaysians have never risen above a relatively simple state of culture. The same is true of the negroid races when not crossed with other strains. If important differences in mental level actually exist, it seems likely that they will be found to fall within the above limits. This would mean that the peoples who maintained themselves in the choice portions of Africa and Asia, and in Europe, probably represent a more or less select group. It is not at all inconceivable that minor evolutionary changes might have occurred in these stocks after the others had been thrust away from the center of dispersion. The natural resources and climatic conditions of these vast continental regions were also favorable factors, and these may have been the most important influences. As we have indicated above, no definite and conclusive evidence for racial differences in mental calibre has been brought forward. There is considerable presumptive evidence, however, which seems to the evolutionist to be rather strong in certain cases at least. This is especially true of the negroid peoples who, it seems reasonable to suppose, broke away from the main human stem early and have long been isolated in regions poor in natural resources and possessing an unfavorable climate.

As already pointed out, the general intelligence level of the several caucasoid races and of the Asiatic mongoloids seems to be about the same. There may be minor differences in mental organisation as between these various races, but nothing of the sort has been discovered as yet. It seems more than likely that most of the traits ascribed to racial temperament and mental organisation are not innate but arise from the cultural background. The institutionalism of modern societies makes for similarity of

behavioral type within a political unit, even when a number of races are included. But even if innate differences of a minor sort exist, this need not mean that one of these races should be regarded as higher than another. The final test of racial superiority is the ability to absorb or develop a highly complex civilisation of some sort. It would be difficult indeed to pass upon the relative value of two distinct, contemporary cultures of approximately the same degree of complexity, except on a personal and subjective basis.

In spite of the facts in the case, the notion seems to persist in some quarters that the Nordic race is somehow superior to the other caucasoid races, not to mention the Asiatic mongoloids. This claim has recently been set forth anew by Günther (58) who deplores the fact that the Alpines are fast absorbing the Nordic peoples. The "Nordic myth" has been exploded by Hertz (62), Hankins (60), and many other authorities, and the arguments need not be repeated here. So far as mental tests are concerned, the Nordic does not rank any higher than the Alpine and Mediterranean when the factors of nurture and selection are reasonably well controlled. Certainly the history of these three races offers no evidence that the Nordic has contributed more than his proportionate share to European civilisation. As Keith has remarked, the basic culture of Europe was evolved by the early Mediterraneans and came to flower in Greece and Rome. It was later absorbed by the Nordics who spread it abroad over western Europe in the course of their wanderings. The Alpines were early leaders in the development of the agricultural life of Europe, and certainly this is a notable contribution. In any event, the races of Europe have almost ceased to exist as such after thousands of years of intermixture. The so-called Nordic countries at the present time represent a Nordic-Alpine mixture with some traces of the old Med-

iterranean strain in certain cases. This is largely true of Germany and England and to a lesser extent of Holland and the Scandinavian countries. As Ripley (65) has shown, pure racial types occur in Europe only in relatively small and isolated regions.

Chapter VII

PRESENT TRENDS IN EVOLUTION

Perhaps no question is of more intrinsic interest to many of us than that regarding the immediate and remote future of mankind. This interest naturally centers around the advanced races which represent the high point of cultural evolution up to the present time. Some writers seem to believe that human evolution is now complete and that further variations of a bodily sort are not to be expected in the future. They would say that human evolution hereafter is to be restricted to various phases of cultural achievement, while man as a biological being is to remain as he is now. Such a view, however, is not only unsound in principle but is contrary to the concrete facts as we find them. To begin with, there can be no such thing as continued existence without bodily change in any living thing. The individual must change from year to year and the species must change from generation to generation. The universal law of life is mutability within limits, and there is not the slightest reason to suppose that the human organism is exempt from its operation. It is evident that the environment of civilised man is far different from that of his immediate and remote ancestors. The shift in external conditions since the beginning of historic times has been relatively rapid and in some cases very important. It may safely be taken for granted that these changes in the environment have brought about further evolution of a biological sort. Our primary problem, in

this connection, is to attempt to determine the trends now in process of realisation. Perhaps, some of these have been carried over from an earlier age and are no longer significant because their force is nearly spent. But there must be others, growing out of more recent conditions, that are to become dominant factors in the future evolution of man.

The evolutionary possibilities of man, as of any other species, depends primarily upon two factors: germinal plasticity and environmental pressure. The stimulus to further evolution arises, as a rule, from the pressure of new external conditions, whereas the limits of change are set by the germinal factor. Germinal plasticity is reduced in any type by a high degree of specialisation along many lines. This follows from the fact that evolutionary processes are irreversible when they have been carried far. The power to take a new direction in a given trait is lost when an organ or part has become highly differentiated. It is quite unlikely, for example, that the woolly hair of the negroid will ever become straight provided no racial crossing occurs. The "mongolian" eye of the Chinese is likewise a fixed germinal character within the strain. The scant bodily hair of the negroid and mongoloid races also represents a permanent loss from the germinal potentialities of the common ancestor of the primary racial stocks. The same principle applies to most of the racial characters which prove to be stable in inheritance. In fact, stability, in this sense, depends upon the germinal restriction which arises from the process of differentiation of organs and parts. The somatic characters, in such cases, may be regarded as an expression of the changes which have taken place in the germinal constitution of the race. The retention by a race of the generalised characters of the common ancestral type is distinctly favorable to further evolution along new lines, other things being equal. On the

other hand, racial specialisation along many lines limits the range of possible later evolution.

Environmental pressure is simply another name for natural selection. New germinal trends are set up whenever the environment changes sufficiently, and these come to fruition if the new conditions are long-continued and the type survives. While the dominant trends are directly related to the new points of pressure, changes of a more or less incidental nature are also likely to occur in the type. Perhaps many of the more superficial racial traits, such as hair texture and skin color have become fixed in this manner. They possess no intrinsic survival value in themselves but they are associated with other traits that are directly affected by some new environmental pressure. In fact, when the latter is severe enough to be highly selective, the whole trait-complex of the species may be more or less affected. This is one reason why it is futile to seek specific environmental factors as causes of specific racial differentiation. The truth is that when the environmental conditions shift in an important way, the type changes not only in direct response to the new pressure, but in numerous other ways that seem to be wholly irrelevant to such pressure. It should be obvious that future evolution is dependent to some extent upon the racial factor. The germinal background of each race is more or less different; that of the primary racial stocks markedly so. Moreover, the environmental pressure at any given time differs for the several races, in so far as they occupy separate regions and possess divergent cultural backgrounds. Perhaps the point should be stressed that biological evolution takes place in response to cultural changes as well as to climatic and other physical conditions. In fact, it is the former rather than the latter which exert the most significant pressure upon man in highly civilised communities. The factors that now comprise natural

selection are largely cultural, since survival has come to depend upon the ability to make social adjustments in the broad sense. Our problem thus resolves itself into an analysis of the effects of civilisation upon the bodily evolution of modern man. In this connection, it is well to remind ourselves that our ancestors, until Neolithic times at least, were nomadic hunters and fishermen. They led an active life in the open country and brawn as well as strategy was an important consideration to survival. They seemed to be well satisfied to live a simple life in which food, clothing, and shelter were the chief requisites. Food was not always abundant and famine often took a heavy toll. Shelters were meagre, as a rule, and only those possessing a strong physical constitution could survive the damp and cold climate of the temperate zones. The birth rate must have been very high and the death rate in infancy and childhood appalling. While these conditions may not seem to us very happy ones, they were favorable to the conservation of a sturdy strength and a rugged physical constitution. Certain of the practices of these early peoples, such as the exposure or voluntary slaying of the weaker infants were also eugenic in their effects. Since war was a matter of individual combat in which the weaker was slain, it tended to be eugenic as well. The basic bodily organisation of man was well adapted to a simple life of this sort, for it had been evolved under still more primitive conditions.

The development of civilisation has brought about a reversal of many of these fundamental relationships. Modern man now lives either in well populated country districts, or in highly concentrated urban centers. The change from rural to urban life has been especially rapid since the beginning of the industrial revolution, and the rate of shift is still on the increase. Brawn has ceased to be of much importance to survival since it is no longer

needed by the man who operates a machine or sits at a desk. Occupational and epidemic diseases have resulted from the new conditions but these have been met by increased medical skill and sanitation. The birth rate under civilisation is low and the death rate of infancy and childhood decidedly so. The latter fact would seem to mean that the weakling has a better chance of coming to maturity and leaving progeny than formerly. Modern warfare takes its heavy toll from the strong and thus has become markedly dysgenic. The development of efficient means of communication has led to the breaking down of racial lines on every hand. The leading centers of civilisation are becoming more and more "melting pots" in which racial distinctiveness threatens to be completely dissolved. Some of these new conditions may be advantageous to the future evolution of man, while others are doubtless disadvantageous. It is easy to see, at any rate, that modern man has entered a new life zone so different from the old that evolution of some sort must be taking place. The principle of natural selection still operates as relentlessly as ever, but the scale of values is different to-day and is likely to shift again to-morrow.

Some of the conditions enumerated above have influenced human evolution very little as yet since they have been in existence for only a few generations. Nevertheless, the anthropologists tell us that civilisation has already begun to leave its mark on the body in the case of the advanced races. Stature and general bodily proportions have probably not changed much on the average, nor has there been an increase in brain size since the beginning of Neolithic times. The investigations of Keith have shown, however, that the facial features of the average Englishman have changed considerably even within the last thousand years. The face is somewhat less broad now than formerly, the palatal arch narrower, and the teeth less well

developed. He attributes these changes to the soft diet and inactive life of to-day—the latter being unfavorable to the normal functioning of the endocrine glands which control growth. He suggests that man may lose his wisdom teeth because of dietary conditions and that this, in turn, will result in a narrower and weaker jaw than at present. This change may be regarded as the continuation of the trend which, by a reduction of the dentary bone, gave man his chin in the first place. The anthropometric studies of Hrdlička have led him to conclude that the teeth of man are becoming smaller, the facial bones thinner, and the face as a whole less broad and massive in appearance. He believes also that the eyes of the civilised races are becoming more deep set with the passage of time. In his opinion, the voice of man is becoming softer and more highly pitched, due to the narrowing of the mouth cavity and nasal passages. It seems altogether likely that most if not all of these trends will continue.

None of the bodily changes just mentioned would seem to be of much consequence in so far as the future welfare of mankind is concerned. In the main, these changes represent losses rather than additions but this does not necessarily imply a deleterious weakening of the human stock. If heavy jaws are no longer needed for purposes of mastication it is not easy to see what advantage would be gained by retaining them. In advancing from the anthropoid level to the status of Homo sapiens man had already lost much of his jaw. This earlier loss was probably due to the fact that man had evolved to the point where he could use his hands instead of his muzzle for the manipulation of objects. Many of the physical traits distinctive of man are in reality merely losses of anthropoid characteristics. In like manner, many of the distinguishing traits of racial stocks and of races represent losses from the ancestral Homo sapiens type. Regardless of their

importance, however, these concrete changes do show that man's bodily evolution is still going on. Many other changes have doubtless occurred which are less easily observed, and some of these may be of genuine importance to human welfare. Most biologists are convinced that the conditions of modern civilisation have set up certain trends which may lead in time to disastrous consequences in the case of the advanced races. In some instances their fears seem to be fully justified while in others the facts do not seem to warrant such a pessimistic view. Certain of these conditions are more or less under the control of man and a change in social policy might still be effective in influencing the final result. In the following section we will discuss briefly the more important trends which are alleged to be fraught with danger to the advanced races, and indicate the methods of control which have been suggested.

Eugenic Control

The science of genetics has made rapid strides during the past few decades. A large amount of experimentation has been carried out on plants and animals, and this has greatly extended our knowledge of the principles of heredity. Much of this work has centered around the general problem of hereditary control in the evolution of new types. As everyone knows, man is now able to produce new and improved varieties of plants and animals to serve his needs and pleasures. Many of the principles which have thus been established are clearly applicable to man himself. It is not strange, therefore, that the question should be raised as to the possibility of improving the germinal background of modern man. Interest in the problem has been strengthened by the widely prevalent belief that the more advanced races are showing signs of degeneracy. In fact, the present aim of the eugen-

ics, or race betterment movement seems to be to stem the tide of growing weakness and thus insure the permanence of the present dominant races. Once this were accomplished, attention would presumably be given to the problem of evolving a race of supermen. In so far as eugenics rests its case upon well-established genetic principles it represents a sound and laudable venture. The movement has not been able to enlist the united support of the biologists, however, because of its extravagant claims and its crusading spirit. Some of its most enthusiastic supporters do not hesitate to fall back upon race prejudices and class distinctions when facts and principles to support their views are wanting. Among the numerous issues which the eugenicist raises, the following seem to be worthy of serious consideration: racial mixture, the contamination of physical and mental defectives, and modern warfare. These will be briefly discussed in order, with a view to determining whether or not they are dysgenic influences of consequence. Our present interest is in the biological rather than sociological aspects of the situations presented by these several factors.

The problem of the germinal effects of racial mixture may be greatly clarified by distinguishing between allied and radical crossings. The former type includes the intermingling of the races of one of the primary stocks while the latter type involves the mixing of the racial stocks themselves. The genetic background of any group of allied races is much the same; that of the primary racial stocks more markedly different. As a rule, there is no race prejudice associated with miscegenation between allied races, and the hybrids are not handicapped by a social stigma of any sort. The three white races of Europe offer a good example of allied race mixture. As we have already observed, these races have been constantly intermingling since the beginning of Neolithic times. The fusion of

the European races in the United States furnishes another excellent illustration. The white population of both Europe and our own country are becoming more and more hybridized and racial lines within these limits are largely fictitious. In like manner, extensive crossing has occurred between the allied races of the mongoloid and of the negroid stocks. Many examples of radical racial mixture could be cited. The White-Negro crosses of the United States and the White-Indian crosses of Mexico and South America may be taken as representative. Mongoloid-negroid mixtures are common in Polynesia and other regions. In some cases, the radical crossings have been so extensive and long-continued that a new racial type has resulted. When both allied and radical mixtures are taken into account the very concept of race becomes somewhat vague. As Gates (72) has remarked, there is no such thing as a pure or homozygous race of mankind at the present time. All human races vary within wide limits in different traits because they are heterozygous for a multitude of factors.

There is no reason to believe that the crossing of allied races results in any ill effects whatsoever. On the contrary, the influence of germinal intermixture within these limits seems to be decidedly advantageous in most cases at least. The hybrid strain is usually characterised for several generations by an increase in size, vitality, and fertility. This phenomenon is known as heterosis, or hybrid vigor, and is due to the fact that the hybrid individual is heterozygous with respect to many inherited characters. This condition favors the manifestation of strong, desirable, and dominant characters rather than weak and recessive characters, for a time at least. Since the genetic background of each race is more or less different, no two races are likely to show the same set of weaknesses throughout. The pooling of the resources of the two races has the effect of increasing the number of strong and dominant

traits in the hybrid. In addition to this general effect, unusual individuals are likely to appear, occasionally, who possess nearly all of the desirable traits of both races. This fact lends color to the view of certain anthropologists that every great civilisation has been preceded by a fusion of races and strains. The Golden Age of Mediterranean Greece came after an admixture of Nordic, Armenoid, and Alpine had taken place. The conquering Romans represented a fusion of all three of the European white races. The present hybrid peoples of Europe and America have forged well to the front in a cultural way. It has long been known that the crossing of strains within the same race improves the stock in the case of plants and animals. The same principles apply in racial outbreeding as in strain outbreeding. In both cases, germinal plasticity is increased in proportion to the dissimilarity of the two stocks, other things being equal. The infusion of new blood into a race really means the infusion of new germinal potentialities. It is true, of course, that a strong race is likely to be weakened by the admixture of the lower strata of a sister race. But a like result also follows from the mixing of strong and weak strains of the same race, hence this is not in itself an argument for the restriction of allied racial crossing.

Some eugenicists assert that the effects of radical racial crossings are genetically bad, but they have brought forward no convincing evidence to sustain their opinion. As might be expected, hybrid vigor usually shows itself in such mixtures just as in the crossing of allied races. Boas found this to be true of certain White-Indian crosses, the half-bloods tending to be taller than either of the parental stocks. A similar finding has been reported by Fischer with respect to the Boer-Hottentot hybrids of southwest Africa. The evidence to date relative to radical mixtures has been summarized by Gates (72) and discussed at

length by Hankins (73). On the whole, the hybrids resulting from the crossing of the primary racial stocks appear to be a strong, healthy, and fertile lot. This is certainly true of the mulatto population of our own country. The problem is somewhat complicated by the fact that radical crossings usually occur between races of unequal social status. This often means that the mixture represents the lower strata of the dominant race which may be actually inferior in genetic background to the average of the socially inferior race. The few instances in which ill effects in the hybrid have been observed belong in this class. But such effects are obviously due, not to the fact of racial crossing, but to the bad hereditary strain of the particular individuals involved in such matings. The claim is sometimes made that races of divergent stocks often differ in bodily proportions to such an extent that crossing results in physical disharmonies in the hybrid. This is certainly not true as between the caucasoid and mongoloid races, in which the degree of difference in traits is relatively small. Although the negroids differ rather markedly from the other two stocks, it seems unlikely that the divergence is great enough to bring about disharmonies of any consequence. Such primitive characters as prognathism, low nasal bridge, and the like tend to disappear in white-negroid crosses. At any rate, no one has yet brought forward a concrete instance of serious physical disharmony in mixtures of negroids with caucasoids or mongoloids when the strains involved were genetically sound.

There seems to be no good reason for placing restrictions upon either allied or radical crossings in so far as the genetic mechanism itself is concerned. While races differ considerably in genetic background and in bodily appearance, even the extremes are similar enough in fundamentals to interbreed and produce strong, fertile offspring. The eugenic motive for preventing radical race mixture,

if it is to be valid at all, must be based upon the broader bio-social aspects of the question. In fact, it must rest upon the postulate of racial inequality in general capacity for the absorption or creation of the type of culture represented in modern complex civilisations. If races are equal in this respect, then laws against miscegenation would seem to be purely arbitrary, so far as bio-social considerations are concerned. The same would be true of immigration laws when these are discriminative along purely racial lines. However, if we are ready to admit essential racial inequalities in cultural capacities, the eugenic value of both types of laws becomes at once apparent. In such a case, the effect of race mixture upon the superior race rather than upon the hybrid deserves most consideration. If mental test scores be taken as the basis of racial ranking, the superior race is depleted by crossing while the hybrid distinctly gains. For, as we have seen, the score is higher for the hybrid than for the lower race represented in the mixture. The general effect of hybridization between races of unequal mental calibre is clearly to reduce the status of the superior race in one way or another. On eugenic grounds, therefore, restrictive measures are justifiable when a race is known to be inferior to another, or when it may reasonably be presumed to be so. The inability of the psychologist to give definite proof of racial inferiority in a given instance offers no excuse for permitting radical mixtures within an advanced racial group. The common assumption of racial inferiority may prove to be a false prejudice in the end, but it is a safe prejudice to hold, from the eugenic viewpoint, until racial equality in cultural capacity has been actually established. As the evidence now stands, such a precautionary attitude would not be unfavorable to crossings between the caucasoid races and the Asiatic mongoloids, since these groups apparently possess the same mental calibre. But these groups might

well oppose crossings with the other races which do not seem to be their equal in mental and cultural capacity.

The eugenics enthusiast often places great emphasis upon the desirability of preserving the purity or constancy of the racial composition of the group. This emphasis would seem to be quite misplaced and serves merely to confuse the issue. The proper aim of eugenics should be to preserve the germinal quality of the group from generation to generation. The racial factor must be regarded as of secondary importance in such a program because of the overlapping of capacities among races. Every race has its good points as well as its bad; its genius as well as its limitations. In like manner every race includes both good and bad germinal strains. Probably, if the truth were known, the worst quarter of the highest race falls far below the average of the lowest race. The effective elimination of the lower races from mixing with the higher by no means closes the gates to bad germinal strains and possible degeneracy. The lower strata of allied races may be a more serious menace to the higher races than the taint of a lower race. There seems to be good reason to believe that the immigrants of the last quarter century from all parts of Europe have been drawn from the lower strata of the caucasoid races there. Instead of seeking to exclude individuals representing bad germinal strains regardless of race, our government has relied upon national quotas which are intended to reflect racial affiliations. The real danger of the American "melting pot" may be poor germinal strains rather than diversity of racial composition. Some of these poor strains are doubtless recent imports, but many of them represent run down lines among the older American families. This is clearly indicated by the low birth rate of large sections of the so-called native stock. Indiscriminate reduction of immigration may prove to be dysgenic in the end, since new blood is con-

stantly needed to replace the depleted native stocks in any highly civilised community. The good effects of hybridisation should not be overlooked in attempting to avoid the possible ill effects of certain kinds of race mixture.

Most biologists would agree with the eugenicist that it would be a wise thing to eliminate the more unsound strains from the group, in so far as this is possible. But the problem is far from simple and involves numerous difficulties on the practical side. To begin with there is no such thing as a strain wholly free from defects. Every strain has its good and bad points just as every race has its good and bad strains. Many serious defects lie dormant for several generations and then make their appearance suddenly in offspring. On the whole, defects are likely to be recessive in character, and often require a determinant from another strain in order actually to develop in the offspring. By a bad strain we mean merely one that yields seriously defective offspring with more or less regularity. It is known, for example, that feeble-mindedness and certain forms of insanity run in families. It has been estimated by East that feeble-mindedness is carried as a recessive by one person out of fourteen in the entire population of the United States. Since defects are so widespread, the most that can be hoped for is to spot the strains that are most tainted in these and other respects. Mating in such cases should be prevented by sterilization or adequate isolation in institutions. But the eugenicists are rarely satisfied with a program so conservative as this. They talk of a well-balanced type as "normal" and seem inclined to think that all who differ from this eugenic "Babbitt" should be uprooted from the land. As Bateson has pointed out, such eugenic caution might have lost to the world such men as Beethoven, Keats, Blake, Cowper, and Francis Bacon. For genius as well as eccentric mediocrity undoubtedly arises from an atypical genetic background. It

should be clear that all limitations placed upon mating tend to reduce the germinal plasticity of the stock and consequently the range of variability in human personality. Such a limitation seems to be advisable in the case of the worst strains. But it would be genetically unsound to attempt to narrow down the germinal potentialities of mankind by allowing only a few "normal" types to breed. If this eugenic standardization were actually realized, it would close the gates to further evolution within the human stock and eventually lead to degeneracy and extinction.

The selection of a fit stock would not be easy, even if it were desirable to limit mating to the best strains. The question of fitness could hardly be trusted to personal judgment and dependable objective criteria are not available. Mere physical tests will not do, since fitness in the eugenic sense has broadly bio-social implications. Even the family geneology has its limitations as a basis for judging of the fitness of a strain. The common opinion that superior people will have superior offspring and inferior people inferior offspring, in the main, has recently been called in question by Pearl. He finds, for example, that 95 per cent of the greatest philosophers, poets, and scientists that ever lived came of mediocre or inferior stock. This conclusion is drawn from a study of all the biographies which occupy a full page or more in the Encyclopedia Brittanica. Much earlier than this, Galton, the founder of eugenics, showed that nine times as many distinguished English jurists were produced by mediocre as by eminent people. The children of distinguished parents are more likely to be themselves distinguished than are the children of mediocre parents, but the total contribution is small. This means that if the world had to depend upon distinguished families for its great men it would be forced to go begging much of the time. It is interesting to note in this connection that the eugenicist often lays great stress

upon the factors of race and social status in settling for himself the question of human fitness. He condemns certain races in wholesale fashion as an ill-bred and tainted lot. The poor of the community are looked upon as relatively unfit, else they would not be so unsuccessful—as if poverty were solely a matter of heredity. The criminal and delinquent class are also unfit, regardless of the nature of their offenses—as if social environment had nothing to do with the determination of human conduct. It is small wonder that many thoughtful biologists and sociologists look askance at a race-betterment program that refuses to face the facts of life. Perhaps, after all, it is better to let nature take her own course than to trust human welfare to prejudiced eugenic reformers.

No one can doubt the dysgenic effects of modern warfare upon both the conqueror and the conquered. Under primitive conditions war seems to have been one of the selective agencies making for a strong and vigorous group life. This was true because fighting consisted primarily in personal encounter and the strength and prowess of the individual increased his chances of survival. In the machine warfare of modern civilized nations, however, the individual counts for little. The men are selected on the basis of physical and mental fitness, for the strain of modern conflict requires the best blood of the land. But individual survival is not dependent to any great extent upon individual strength and prowess. The strong and the weak are killed and maimed indiscriminately and *en masse* by the machine. The sacrifice of large numbers of youth under these conditions can mean nothing less than the wholesale depletion of the germinal potentialities of mankind. The normal contribution of this selected group to future generations is permanently lost. The germinal plasticity upon which future evolution depends is reduced in range and impoverished. Surely the preservation of

good strains is as important to human welfare as the elimination of bad strains. In fact, the losses of war are of much more consequence, from the eugenic standpoint, than any other aspect of the general situation. In spite of this obvious truth, the eugenic enthusiast is often numbered among the junkers of his nation. The feeling seems to be widespread that the nation with the highest capacity for culture will always win. The record of history definitely contradicts this notion. But even if it were true, the conqueror as well as the conquered must stand the loss of a depleted generation of youth. It may well be that the biological cost of war has become too great a price to pay for cultural distinctions that may be of doubtful value in the end.

Evolution and Progress

It is clear that the germinal background of modern man continues to change within undetermined limits in response to the selective action of external conditions. These germinal changes are reflected in structural and functional variations, some of which are doubtless of great importance to the future course of human evolution. As Conklin has remarked, mutations of many sorts, good, bad, and indifferent, are occurring more or less continuously in the human race. The new conditions of life imposed by civilisation are agencies of evolution in so far as they exert an influence upon the selective process. We have already noted that certain trends in facial features and in the internal structure of the throat and mouth are now observable in the civilised races. Boas has recently called attention to the effects of change of habitat upon such relatively stable characters as head-form and face-form in certain immigrant groups. He found that these and other traits changed considerably even in the first generation

born in America, when no mixture with American stocks had taken place. The differences between parents and children ran in opposite directions as between long-headed Sicilians and round-headed Jews of eastern Europe. These observations favor the view that modern civilized man is still plastic and is likely to change considerably in the future. Racial mixture is steadily on the increase, and this obviously results in changing the human type, since it brings about new gene combinations in the hybrid population. The physical and mental weaklings seem to have a somewhat better chance to survive under modern conditions, and this means an increase in germinal contamination from this source. This undesirable addition, together with the loss of the best blood in modern warfare, must also influence the direction of human evolution in time. Perhaps these two unfavorable conditions may be remedied by a sensible program of eugenic control, but nothing of outstanding importance has been accomplished to date.

The question naturally arises at this point as to whether the continued evolution of man under the conditions of modern civilisation means genuine progress or not. That this is not necessarily true is apparent from the distinction which was developed between the concepts of evolution and of progress in Chapter I. The term evolution, whether applied to the organism or to culture, connotes merely the fact of change in a given direction, regardless of the influence of the trend upon the well-being of the organism. The notion of progress, on the other hand, can be applied only to trends which are favorable to the survival of the organism in a superior bio-social environment. It is important to note that both the basic biological factors and the secondary cultural factors must be given due consideration in drawing conclusions regarding human progress. The mere fact of survival at a low level of existence could

hardly be called progress. It is just as true, however, that a high level of culture does not mean progress if it is gained at the expense of a weakened organism which will be unable to survive in the end. It is well to remember, moreover, that there is no close parallel between the evolution of man's body and the evolution of his cultural environment. The former proceeds at a slow rate while the latter is both more fundamental in character and rapid in rate. Certain cultural changes serve as extensions of bodily capacities, and these in a measure offset the need for further physical evolution. Nevertheless, there are those who hold that there is an essential antagonism between the biological capacities of man and the demands made upon him by the increasing complexity of civilisation. They would say that an extremely complex civilisation involves a certain strain that man's physical constitution is unable to bear, and that the limit in this respect has already been passed by the caucasoid races. They profess to see signs of physical and mental degeneracy on every hand, and especially so in the great centers of cultural advance.

This pessimistic view may be more or less true, in so far as its application to races and nations is concerned. If history is to be trusted, peoples like individuals pass through a cycle of development in which the vigor of youth and the strength of middle age are followed by senility and decline. The great nations of Egypt, Greece, and Rome will serve as familiar examples from the past. In each case, the nation was recruited from rugged rural populations and remained virile and strong for a time, as shown by a high birth rate and a rapid extension of political dominion. But eventually large urban centers were developed, the birth rate dropped, art and culture came to flower, and the weakened peoples were absorbed by primitive groups that had not yet tasted the forbidden fruit of a complex and refined civilisation. Much the same thing seems to

have happened in the case of the ancient Mayan people of the New World. Spengler and others would have us believe that the nations of western Europe and North America have already passed the zenith and are now in the last stages of decline.

No one can deny that the caucasoid birth rate has been rapidly decreasing for some decades. This is due in part at least to the development of large urban centers. A low birth rate is characteristic of urban communities and of a high standard of living in general. The college-bred group and the professional classes hardly replace themselves from generation to generation in our own country. The population of America is being kept up in large part by the European immigrants of the peasant class, among whom the birth rate is still fairly high. Perhaps it is true that a complex civilisation saps the vitality and strength of a race and people. But if it is true, the underlying causes are probably so general and fundamental that they are quite beyond human control. The eugenicist seems to feel that this threat to caucasoid supremacy can be met by such measures as "a back to the farm" movement and an increase in the birth rate among the so-called better classes. It ought to be obvious, however, that no amount of reform propaganda will ever induce the civilised man to return to a rude pastoral life, or to revive the large family of his forefathers. A more logical remedy would seem to be a steady absorption of a healthy alien peasant stock from Asia as the native European races become depleted. If such a bio-social cycle as we have described is normal in the sense of inevitable, then the Asiatic mongoloids may sometime supplant the white race as the standard-bearers of the cultural advance. For "the passing of a great race" does not mean the end of human culture, so long as other races are left behind which have the physical strength and mental calibre to carry on.

While the notion of a normal developmental cycle for races and peoples seems to fit past and present conditions reasonably well, we have no real assurance that it will hold for the future. Several other possibilities suggest themselves as equally probable from the speculative viewpoint. Perhaps man's physical evolution will fit him for life in a complex cultural environment if the latter proves to be long-continued. If the germinal plasticity of modern man is sufficient for this it is precisely what might be expected. The selective action of the new environmental pressures resulting from civilisation should work in the direction of adjusting man's bodily capacities to the new conditions. But there is a limit, of course, to what physical evolution can do for man in this respect. Up to the present, man has made a good showing at offsetting the physical ills resulting from civilisation by his inventive genius, and this is likely to continue. This tends to make man dependent upon specific artificial factors, but this is a matter of small consequence so long as these continue under human control. But the possibility remains that some great secular change might take from man his present control of environmental factors to a large extent at least. Many geologists believe, for example, that we are now living in an interglacial rather than a postglacial period. If this is true we may expect that, sooner or later, the northern part of Eurasia and America will be covered by a great continental ice sheet as in Pleistocene times. This would mean the destruction of civilisation in these regions and the migration of the caucasoid and mongoloid races southward, and lead to racial intermixture on a grand scale. Even this might have its advantages, however, for it would probably bring about the extermination of the weaker peoples and lead to the evolution of a strong and virile stock that might well be superior to any human type that has yet appeared. On the whole, the forces of evolution are

so manifold and inscrutable that it is useless to attempt to predict the course of human evolution that lies ahead. But if the direction of evolution cannot be predicted then surely the question of human welfare and human progress must be left to the future.

BIBLIOGRAPHY

CHAPTER I

SOME PROBLEMS OF HUMAN EVOLUTION

1. BAITSELL, G. A. (Ed.). 1929. "The Evolution of Earth and Man." New Haven, Yale Univ. Press, 476 pp.
2. CONKLIN, E. G. 1915. "Heredity and Environment in the Development of Men." 5th rev. ed. 1923. Princeton Univ. Press, 379 pp.
3. KELLOGG, V. L. 1907. "Darwinism To-day." New York, Holt, 403 pp.
4. NEWMAN, H. H. 1921. "Evolution, Genetics and Eugenics." 2d ed. 1925. Chicago, Chicago Univ. Press, 639 pp.
5. OSBORN, H. F. 1917. "The Origin and Evolution of Life." New York, Scribner, 322 pp.
6. OSBORN, H. F. 1922. "From the Greeks to Darwin." 2d ed. 1929. New York, Scribner, 398 pp.
7. WARDEN, C. J., JENKINS, T. N., and WARNER, L. H. 1932. "A Textbook of Comparative Psychology." New York, Ronald Press.

CHAPTER II

THE NATURAL KINSHIP OF MAN AND ANIMAL

8. GOODRICH, E. S. 1930. "Studies on the Structure and Development of Vertebrates." London, Macmillan, 837 pp.
9. GREGORY, W. K. 1922. "The Origin and Evolution of Human Dentition." Baltimore, Williams & Wilkins, 548 pp.
10. GREGORY, W. K. 1929. "Our Face from Fish to Man." New York, Putnam, 295 pp.

11. Herrick, C. J. 1924. "Neurological Foundations of Animal Behavior." New York, Holt, 334 pp.
12. Keith, Sir A. 1920. "Man: a History of the Human Body." New York, Holt, 251 pp.
13. Keith, Sir A. 1921. 4th ed. rev. "Human Embryology and Morphology." New York, Longmans, Green, 491 pp.
14. Sonntag, C. F. 1924. "The Morphology and Evolution of the Apes and Man." London, Bale & Danielsson, 364 pp.
15. Tilney, F. 1929. "The Brain from Ape to Man." New York, Hoeber, 2 vols.

Chapter III

WHEN ANTHROPOID BECAME HUMAN

16. Bierens de Haan, J. A. 1929. "Animal Language in Its Relation to That of Man." *Biol. Rev.*, 4: No. 3, pp. 249–68.
17. De Laguna, G. A. 1927. "Speech, Its Function and Development." New Haven, Yale Univ. Press, 363 pp.
18. Hrdlička, A. 1931. "Children Who Run on All Fours." New York, McGraw-Hill, Whittlesey House, 418 pp.
19. Jespersen, O. 1922. "Language: Its Nature, Development and Origin." New York, Holt, 448 pp.
20. Keith, Sir Arthur. 1928. "Concerning Man's Origin." New York, Putnam, 188 pp.
21. Miller, G. S. 1928. "Some Elements of the Sexual Behavior in Primates and Their Possible Influence on the Beginnings of Human Social Development." *J. Mammology*, 9: pp. 273–93.
22. Paget, Sir Richard. 1930. "Human Speech." New York, Harcourt, Brace, 360 pp.
23. Pillsbury, W. B., and Meader, C. L. 1928. "The Psychology of Language." New York, Appleton, 306 pp.
24. Sapir, E. 1921. "Language: An Introduction to the Study of Speech." New York, Harcourt, Brace, 258 pp.
25. Schultz, A. H. 1926. "Fetal Growth of Man and Other Primates." *Quart. Rev. Biol.*, 1: pp 465–521.

26. STRAUS, JR., W. L. 1930. "The Foot Musculature of the Highland Gorilla." (Gorilla-Beringei). *Quart. Rev. Biol.*, 5: pp. 261–317.
27. VENDREYS, J. 1925. "Language: A Linguistic Introduction to History." Eng. tr. by Paul Radin. New York, Knopf, 378 pp.
28. WARDEN, C. J., and WARNER, L. H. 1928. "The Sensory Capacities and Intelligence of Dogs, with a Report on the Ability of the Noted Dog 'Fellow' to Respond to Verbal Stimuli." *Quart. Rev. Biol.*, 3: pp. 1–28.
29. YERKES, R. M., and YERKES, A. W. 1929. "The Great Apes." New Haven, Yale Univ. Press, 652 pp.

CHAPTER IV

TRACES OF EARLY MAN

30. CARTAILHAS, E. 1906. "La Caverne d'Altamira." Monaco, 278 pp.
31. HRDLIČKA, A. 1920. "Anthropometry." Philadelphia, Wistar Institute of Anatomy and Biology, 163 pp.
32. HRDLIČKA, A. 1930. "The Skeletal Remains of Early Man." Washington, Smithsonian Pub., 379 pp.
33. KEITH, SIR ARTHUR. 1915. "The Antiquity of Man." New and enlarged ed. 1928. Philadelphia, Lippincott, 2 vols.
34. LUQUET, G. H. 1930. "The Art and Religion of Fossil Man." Eng. tr., Russell, J. T. New Haven, Yale Univ. Press, 213 pp.
35. MACCURDY, G. G. 1924. "Human Origins: A Manual of Prehistory." New York, Appleton, 2 vols.
36. MOIR, J. REID. 1920. "Pre-Paleolithic Man." Ipswich, Harrison, 67 pp.
37. OSBORN, H. F. 1915. Third ed. 1918. "Men of the Old Stone Age." New York, Scribner, 559 pp.
38. OSBORN, H. F. 1928. "Man Rises to Parnassus." Princeton, Princeton Univ. Press, 251 pp.
39. POND, A. W. 1930. "Primitive Methods of Working Stone Based on Experiments of Halvor L. Skavlem." Logan Museum, Beloit College, Beloit, Wis., 143 pp.

40. SANDFORD, K. S., and ARKELL, W. J. 1929. "Paleolithic Man and the Nile-Faiyum Divide." Chicago, Univ. of Chicago Press, 77 pp.
41. SMITH, G. ELLIOT. 1924. "The Evolution of Man." 2nd ed. rev. 1927, Oxford Univ. Press, 195 pp.
42. WILDER, H. H. 1920. "A Laboratory Manual of Anthropometry." Philadelphia, Blakiston, 193 pp.

CHAPTER V

THE COMING OF MODERN MAN

43. ANDREWS, R. C. 1926. "On the Trail of Ancient Man." New York, Putnam, 375 pp.
44. BURKITT, M. C. 1926. "Our Early Ancestors." New York, Macmillan, 243 pp.
45. CHILD, V. G. 1925. "The Dawn of European Civilisation." New York, Knopf, 328 pp.
46. CHILD, V. G. 1930. "The Bronze Age." New York, Macmillan, 258 pp.
47. COLLINS, H. B. 1929. "Prehistoric Art of the Alaskan Eskimo." Washington, Smithsonian Inst. Pub. No. 3023, 52 pp. (24 plates).
48. SOLLAS, W. J. 1924. "Ancient Hunters." Third ed. rev. New York, Macmillan, 689 pp.
49. SMITH, G. E. 1929. "Human History." New York, Norton, 472 pp.
50. TYLER, J. M. 1922. "The New Stone Age in Northern Europe." New York, Scribner, 310 pp.
51. VERRILL, A. H. 1929. "Old Civilisations in the New World." Indianapolis, Bobbs-Merrill, 393 pp.

CHAPTER VI

RACE AND CIVILISATION

52. BEAN, R. B. 1926. "Human Types." *Quart. Rev. Biol.*, 1: pp. 360–92.
53. BOAS, F. 1928. "Anthropology and Modern Life." New York, Norton, 246 pp.

54. CIOBAN, E. A. 1931. "A Survey of Racial Differences." Master of Arts Thesis, Columbia University Library, New York City.
55. DENIKER, J. 1900. "The Races of Man." London, Scott Publishing Co., 611 pp.
56. DIXON, R. B. 1923. "The Racial History of Man." New York, Scribner, 583 pp.
57. GARTH, T. R. 1931. "Race Psychology: A Study of Racial Mental Differences." New York, McGraw-Hill, Whittlesey House, 260 pp.
58. GÜNTHER, H. F. 1927. "The Racial Elements of European History." Eng. tr. by G. C. Wheeler. London, Methuen, 279 pp.
59. HADDON, A. C. 1925. "The Races of Man and Their Distribution." New York, Macmillan, 201 pp.
60. HANKINS, F. H. 1926. "The Racial Basis of Civilization." New York, Knopf, 384 pp.
61. HAVEMEYER, L. 1929. "Ethnography." New York, Ginn & Co., 522 pp.
62. HERTZ, F. 1928. "Race and Civilization." Eng. tr. by Levetus and Entz. New York, Macmillan, 328 pp.
63. HUNTINGTON, E. 1924. "The Character of Races." New York, Scribner, 393, pp.
64. PATERSON, D. G. 1930. "Physique and Intellect." New York, Century, 304 pp.
65. RIPLEY, W. Z. 1899. "The Races of Europe." New York, Appleton, 624 pp.
66. SERGI, G. 1901. "The Mediterranean Race: a Study of the Origin of European Peoples." New York, Scribner, 320 pp.
67. STOCKARD, C. R. "The Physical Basis of Personality." New York, Norton, 320 pp.
68. THOMAS, F. 1925. "The Environmental Basis of Society." New York, Century, 336 pp.

CHAPTER VII

PRESENT TRENDS IN EVOLUTION

69. BURY, J. B. 1920. "The Idea of Progress." London, Macmillan, 377 pp.

70. Cowdry, E. V. (Ed.). 1930. "Human Biology and Racial Welfare." New York, Hoeber, 612 pp.
71. Ellwood, C. A. 1927. "Cultural Evolution." New York, Century, 266 pp.
72. Gates, R. R. 1929. "Heredity in Man." New York, Macmillan, 385 pp.
73. Hankins, F. H. 1927. "An Introduction to the Study of Society." New York, Macmillan, 760 pp.
74. Jennings, H. S. 1930. "The Biological Basis of Human Nature." New York, Norton, 384 pp.
75. Reuter, E. B. 1931. "Race Mixture: Studies in Intermarriage and Miscegenation." New York, McGraw-Hill, 224 pp.
76. Thompson, W. S. 1930. "Population Problems." New York, McGraw-Hill, 462 pp.

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