APES GIANTS AND MAN

By

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PREFACE

THIS book presents five lectures, delivered by the author at the University of California during April and May, 1945, in his position as Hitchcock Professor. The Hitchcock Endowment Fund was established by the late Charles M. Hitchcock as an endowment for "a professorship in the University of California for free lectures upon scientific and practical subjects but not for the advantage of any religious sect nor upon political subjects."

Although the lectures discuss the general problem of the physical evolution of man, the individual lectures are more or less independent of each other. Each one deals with a selected topic, chosen as the most adequate to give the reader a concise and complete idea of the essential transformations of the human body and the human species as they appear from the records of the past. Each of the chapters of the book covers one of the lectures delivered. All have been somewhat augmented. The chapter dealing with the principles of racial classification has been more elaborated than the others.

The facts reported and the conclusions drawn from them have been obtained chiefly from the author's own studies of the fossil material. The main publications concerning these facts and conclusions are listed in the Bibliography. The reader who wants to consult other sources for more detailed information will find, in addition, publications of earlier authors, particularly those which have been referred to in the text or illustrations.

FRANZ WEIDENREICH

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INTRODUCTION

THE preamble to the Declaration of Independence of the United States of America "holds the truth as self-evident that all men are created equal." This knowledge, attained by the Encyclopedists of the eighteenth century and esteemed as one of the great moral achievements of modern times, was challenged in the middle of the nineteenth century by Count Gobineau in his famous book *L'Inegalité des races humaines.* The Encyclopedists and Count Gobineau had two different issues in mind. The former thought of the right of equal treatment before the law and based their idea on the fundamental equality of both physical and mental properties of the human creature, as compared with other products of creation. Count Gobineau, on the other hand, saw only the differences of individuals and groups of individuals within the human community and deduced from these inequalities the right of discrimination.

Gobineau discussed whether the Negroes are included when the Bible refers to "man" and asks whether they did not derive from another human line than that which took its origin from Adam. It is strange to note that Gobineau's ideas about Negroes are not fundamentally discordant with those of certain modern taxonomists and geneticists who believe that Linnaeus' species Homo sapiens refers only to the white man and that, therefore, Negroes or other races should be classified as different species.

It admits of no doubt that differences between men of today do exist. They can be observed by everyone and grouped and named in various ways according to the individual interpreter. Yet, despite the many attempts to divide the creatures which are called "man" in smaller or greater subgroups, they represent a single continuous line of forms; each group, no matter by what means or where it may be picked out, remains connected with other groups by intermediate forms. It is, of course, scientifically correct to break off continuities and designate the chosen units by special names; but it must always be kept in mind that any partition is based on an arbitrary generalization, especially when the sections are small.

Notwithstanding all the racial differentiations, man is a unit when considered as an organism. The organization of his body and, consequently, the physical substratum of his mind are, in all individuals and subgroups, fundamentally the same, having evolved from a nonhuman ancestor to the same final product, regardless of time and space. The members of present mankind, whatever their physical appearance and geographical distribution may be, reveal the irresistible trend and faculty to interbreed. In no cases have sexual aversions been manifested unless enforced by the interference of man himself. This fact proves that mankind in its entity represents one species in the morphological or physiological sense of this term. Differences among even the most diverging subgroups are not greater than those found between the manifold races of domesticated animals. On the contrary, as far as size, proportions, and special features of the body or nuances in the complexion or the texture of the hair are concerned, the overwhelming majority of those differing features are much smaller in man than those encountered in animals which have been submitted to domestication.

Unfortunately, there is no objective gauge which can be used for the measurement of the grade of morphological deviations and for the determination of the limits between individual, specific, and generic variants. Such a distinction is left entirely to the "opinion of naturalists having sound judgment and wide experiences," as Charles Darwin has put it. Therefore, raising the differences between racial groups to the rank of specific differences by giving those groups specific names is nothing but an attempt to exaggerate the dissimilarities by the application of a taxonomic trick.

All that is known of the ancestors of modern mankind reveals that each distinguishable phylogenetic phase displays a certain diversity of forms. Combining these forms in subgroups or races is justified if evidence can be offered that the grade and amount of the diverging features surpass those of the usual individual variants. On the other hand, no fossil type of man has been recovered so far whose characteristic features may not easily be traced to modern man. The degree of this conformity determines the morphological age of the specimen concerned. Although there are still gaps in the evolutionary line—obviously

due to the scarcity of the material—some features, fortunately the most characteristic ones, bear witness to the continuity of the phylogenetic development which took place. As far as the skeleton is concerned, phylogenetic differences usually affect characters different from those which signify group differences within the same evolutionary phase. But an overlapping of the two kinds of variations always occurs to a smaller or greater extent, as evinced by the conditions found in modern mankind. This fact is of general importance, for it proves that truly basic differences between individual and group or phase variations do not exist. Since interbreeding in modern man happens, despite all individual or group variations, the interchange obviously was not stopped when these variations assumed the character of phase variations. If this had been true, the human evolutionary line would show clear morphological signs of interruption. Since these cannot be demonstrated, the limits of the human species itself have not coincided with the limits of evolutionary phases. Moreover, most of the gradual intergroup changes which have been recognized so far seem not to transcend the limits of intragroup variations. Therefore, not only the living forms of mankind but also the past forms—at least those whose remains have been recovered—must be included in the same species.

Scientists who have acknowledged the accuracy of these conclusions have urged me to draw the consequences of this theory and change the nomenclature correspondingly. They wish me to eliminate all the generic names heretofore given to fossil specimens and to adapt the nomenclature to the requirements of Linnaeus' taxonomical principles. However, I have refused. In paleontology it always was and still is the custom to give generic or specific names to each new type without much concern for the kind of relationship to other types formerly known. Furthermore, the old names of fossil human types are accepted throughout the entire literature dealing with early man, so that any radical change would lead to the greatest confusion and necessitate complicated explanations in each case. I shall continue, therefore, to use the old names without imputing a special taxonomical meaning. However, this shall not exclude their application in phylogenetic classification, as will be shown in chapter i.

CHAPTER I

MAN AND HIS SIMIAN ANCESTRY

> Was the oldest Homo sapiens pliocene or miocene? In still older strata do the fossilified bones of an Ape, more anthropoid, or a Man, more pithecoid than any yet known, await the researches of some unborn paleontologist?
>
> —THOMAS H. HUXLEY

MAN, as zoölogically defined, has been ranked by Linnaeus with the order of the Primates, together with the prosimians and simians, on account of the similarity of the bodily organization of this group. Although Linnaeus recognized that man has to be put at the top of this order, Thomas Huxley was the first to define man's exact taxonomic position within the primate group. He stated: "Whatever system of organs may be studied, the comparison of their modifications in the ape series leads to one and the same result—that the structural differences which separate man from the gorilla and chimpanzee are not as great as those which separate the gorilla from the lower apes."

This statement settled, once and for all, the question of the special place of man in the zoölogical system. But if we want to know the course taken by human evolution, we have to take into account not the congruities between the organization of man and the great apes but their most characteristic differences. One of the most conspicuous and first-recognized differences has been expressed in the slogan that man has two hands, whereas the apes have four. Although this is anatomically incorrect, it hits the spot. Apes, like man, have two hands and two feet; but man alone has acquired an upright position and the faculty to use his feet exclusively as locomotor instruments, while the apes stand and walk on all fours, or, in other words, employ their hands for locomotion. This basic difference becomes manifest not only in the construction of the foot but also in the construction of the vertebral column and the lower limb, and it is

strongly reflected in the construction of the skull as well (Weidenreich, 1924). Unless all the signs are deceiving, the claim may even be ventured that the change in locomotion and the corresponding alteration of the organization of the body are the essential specializations in the transformation of the prehuman form into the human form. Fortunately, all these changes find their expression in the skeleton, so that they can be traced back to the earliest fossil remains, when chance may give them into students' hands.

The upright posture of man, compared with the condition of the apes, is characterized, among other peculiarities, by the following features: (1) The long bones of the lower limb, especially the thighbone, are longer in man than the long bones of the upper limb, especially the humerus, while in anthropoids the conditions are reversed (Fig. 17). (2) The bones of the tarsus, the posterior portion of the foot, are relatively long and large, while the toes are short. In anthropoids these conditions are reversed; here the tarsal bones are relatively smaller and the toes longer (Figs. 1 and 2). (3) The human trunk is short in proportion to the length of the lower limb, while here, again, the conditions are reversed in anthropoids (Fig. 1). (4) The human vertebral column is curved alternately forward and backward, while it is straight or curves uniformly backward in anthropoids (Figs. 1 and 3). (5) In upright position the human leg is stretched in hip and knee joints to its maximum extent and adduced toward the midline, so that the knees touch each other (Fig. 3), while in anthropoids, even if the latter succeed in standing and walking upright, the legs remain bent in hip and knee joints and are held in abduction, so that anthropoids always stand stooped, with their knees crooked and turned outward (Figs. 1 and 4). (6) The joint between the skull and the vertebral column is placed almost in the center of the base of the human skull, while it is close to the posterior end in anthropoids (Fig. 11).

Most of these peculiarities are shown in Thomas Huxley's famous drawings of the skeletons of the three anthropoids and men (Fig. 1). But Huxley placed more emphasis on similarities in this illustration than on dissimilarities, because he wanted

to show that the organization of the human skeleton is, in principle, that of an anthropoid. Therefore, he depicted the great apes in an "erect" position but man in a not completely erect one. In other words, the individual skeletal elements in Huxley's drawings are nearly correct in their form and proportions, but the poses Huxley has given them are artificial and not characteristic. Figure 3 shows man in a schematic but correct upright posture, with hip and knee joints stretched at maximum, while anthropoids never are able to stretch their legs when standing on their feet without any handhold (Figs. 1 and 4).

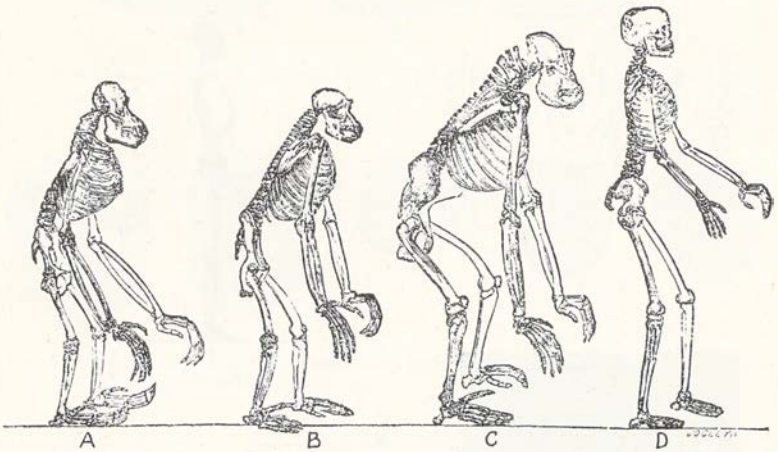

FIG. 1.—Skeletons of orangutan (*A*); chimpanzee (*B*); gorilla (*C*); and man (*D*) The anthropoids are in artificially erect positions, man is slightly stooped. (After Thomas H. Huxley.)

The adoption of erect posture has brought about certain structural peculiarities in almost each individual bone of the human skeleton, so that it is possible to determine whether it belongs to a man or to an ape even when only small fragments have been preserved. The most characteristic criteria concern the skull form (cf. Weidenreich, 1943) and the pattern of the teeth (cf. Weidenreich, 1937). The number of the teeth and that of their types are the same in man and anthropoids; but the human canines are in no case large, far-projecting fangs, nor does the crown of the first lower premolar carry a sharp blade which works in combination with the edge of the upper canine, like a pair of scissors, to cut the food. Figures 5 and 6 show the differ-

ences between the lower canines and the lower first premolars of gorilla (*A*) and modern man (*B*) in occlusal (Fig. 5) and lateral (Fig. 6) views of the jaws. Compare, also, the differences in the upper canines in Figure 8, *A*, *B*, and *C*. The general pattern of the lower molars, the most characteristic teeth for comparative purposes, is the same in man and anthropoids, so far as number and arrangement of the cusps are concerned; but the form and size of the cusps and, in particular, the details of the relief of their chewing surface are so specifically different that man and each of the anthropoid types can be distinguished at first glance,

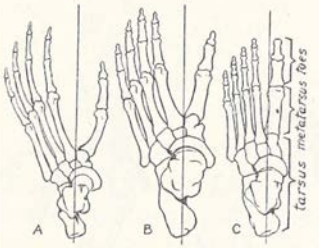

Fig. 2

Fig. 3

Fig. 4

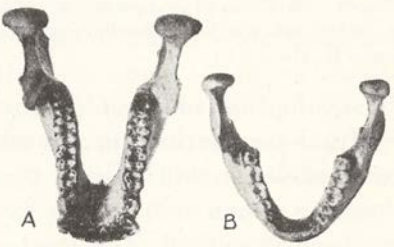

Fig. 5

Fig. 2.—Skeletons of the foot of chimpanzee (*A*); gorilla (*B*); and man (*C*). (After D. J. Morton.)

Fig. 3.—Scheme of the human skeleton in erect position. (After G. Mollier.)

Fig. 4.—Chimpanzee standing erect without any handhold. (Photograph taken by the author.)

Fig. 5.—Lower jaws of a female gorilla (*A*); and a modern northern Chinese (*B*) in occlusal view, to show the differences of their canines and first premolars.

provided the chewing surface has not been worn down too much by attrition (Fig. 7, series of lower molars of: gorilla (*A*); orangutan (*B*); chimpanzee (*C*); Sinanthropus (*D*), and modern man (*E*). The human dental arch is a widely spanned curve, with diverging side rows and sharp bends in the place of the canines;

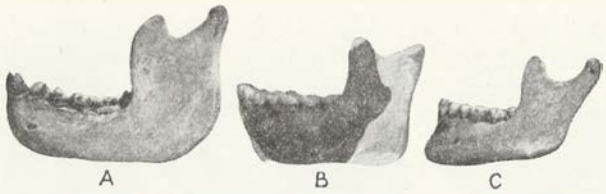

FIG. 6.—The same jaws in lateral view: gorilla (*A*); Sinanthropus pekinensis (*B*); modern northern Chinese (*C*).

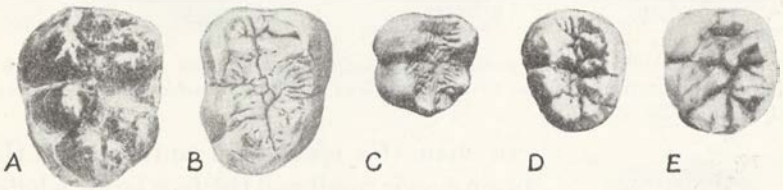

FIG. 7.—Lower molars of anthropoids and man: gorilla (*A*); orangutan (*B*); chimpanzee (*C*); Sinanthropus (*D*); modern man (*E*). ×1½.

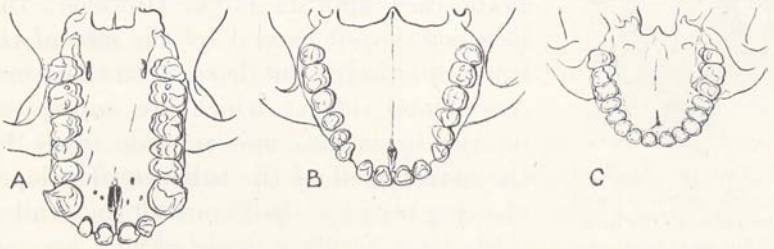

FIG. 8.—Upper dental arches of gorilla (*A*); Pithecanthropus robustus (*B*); and modern man—paleolithic man of the "Upper Cave" of Choukoutien (*C*). The rate of reduction is the same in all three skulls.

while the anthropoid dental arch is compressed, with pronounced bends and almost parallel side rows. Figure 5 illustrates this condition of the lower jaw: (*A*) gorilla and (*B*) modern man; and Figure 8 that of the upper jaw: (*A*) gorilla, (*B*) Pithecanthropus robustus, and (*C*) modern man.

The differences in dentition and dental arch are closely correlated with those in form and structure of the skull (cf. Weidenreich, 1941*b*). In both anthropoids and man there is a conspicuous disproportion between the size of the face, represented chiefly by the two jaws and the size of the brain case, as the lateral views of the skulls (Fig. 9) of a male gorilla (*A*) and a male mod-

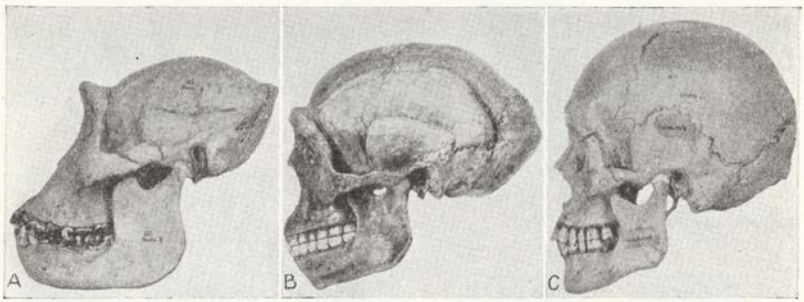

FIG. 9.—Skulls of female gorilla (*A*); Sinanthropus pekinensis—reconstructed (*B*); and modern northern Chinese (*C*). Lateral views. The rate of reduction is the same in all three skulls.

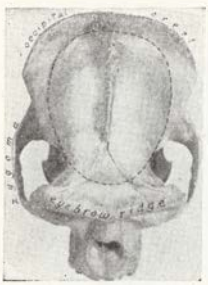

FIG. 10.—Skull of a male gorilla, viewed from above. The broken line marks the outer contour of the brain case. All parts beyond this line represent "superstructures" (occipital crest, zygoma, eyebrow ridges).

ern man (*C*) reveal. In anthropoids the brain case is small and the face large, whereas reverse conditions occur in man. In the male gorilla and orangutan the size of the brain case appears large. However, this largeness is not caused by the size of the brain case proper but depends on structures (crests and ridges) which are superposed on the brain case and provide space for the attachment of the mightily developed chewing muscles. In Figure 10 the skull of a big male gorilla is depicted as it appears in vertical view. The outlines of its brain case are indicated by dashes. All structures outside of the brain case proper —the eyebrow ridges, the zygoma with its root, and the occipital crest—are secondary structures, "superstructures." Even in the biggest gorilla ever observed, the cranial capacity did not exceed 620 cc., while the average of the whole anthropoid group is only

415 cc. In man, speaking of the modern type, the average capacity is more than three times that of the anthropoid average. His brain case is correspondingly large; and his face, particularly the jaws, proportionally small. While anthropoids (Fig. 9, *A*) have a far-protruding snout, there is not real facial prognathism in man (Fig. 9, *C*); and, since the human chewing apparatus is small compared with that of the anthropoids, the crests and ridges of the brain case are completely wanting. In addition, the whole topographical arrangement of brain case and face is different. In anthropoids, the face is placed in front of the brain case (one of the reasons why the jaws protrude to such an extent); in man, the brain case tops the face, which itself has receded beneath the brain case. Mid-sagittal sections (Fig. 11)

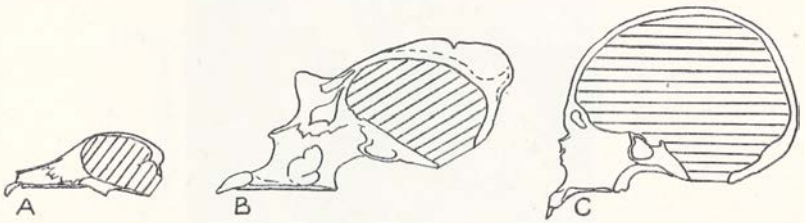

FIG. 11.—Mid-sagittal section through the skulls of a dog (*A*); male gorilla (*B*); and modern man—New Britain (*C*), to show the differences in the topographical orientation of brain case and face. (After W. L. H. Duckworth.)

through the skull of a dog (*A*), gorilla (*B*), and modern man (*C*) reveal this different topographical orientation of brain case and face.

If the human form has gradually evolved from a simian one, the type from which it originated must have had the general appearance of an anthropoid and shown a corresponding organization of body and skeleton. The types which precede modern man must, therefore, resemble the anthropoid organization all the more, the farther they are from the modern type. Yet in this consideration there is one point which has delayed the right conception and understanding of the evolutionary process for a long time. This was the idea that the older the morphological age of the human form is, the more it must approach the living anthropoids. This conclusion did not take into account that the big apes, too, must have undergone essential changes during the

same period of time in which man evolved. How great the illusions have been in this regard can be illustrated best by a painting of the renowned German artist, Gabriel Max. He reconstructed the Java man (Pithecanthropus) as a creature about intermediate between the living orangutan and modern man in appearance and attitude (Fig. 12).

Whether chimpanzee or gorilla or orangutan was the next-of-kin to man was long and earnestly debated, while the other al-

FIG. 12.—A "missing link," called Pithecanthropus allalus. Painting of Gabriel Max, reproduced in Ernst Haeckel's *Natürliche Schöpfungsgeschichte.*

ternative, namely, that the three anthropoids themselves are the products of special differentiations leading them also away from the archetype, was scarcely discussed. The anatomical facts that have been revealed by comparative studies in recent years have made it more and more likely that the three living anthropoids are diverging branches of an anthropoid stem which deviated as such from the same main stock, of which man represents another line.

I referred earlier to the fundamental differences between man

and anthropoids in the form and size of the canines and the first lower premolars. Considered from the new perspective, the question is: Were these human teeth originally like those of anthropoids, and have they been reduced and transformed during evolution into the human type; or, on the contrary, were the anthropoid teeth originally more like human teeth, and consequently are their fanglike canines and the sectorial character of their first lower premolars secondary acquisitions? Some years ago, almost all anthropologists and comparative anatomists were convinced that only the first alternative could be taken seriously. But the discoveries of recent years have revealed that the tooth patterns of early man, even in the most primitive forms, remained basically the same as those of the later phases

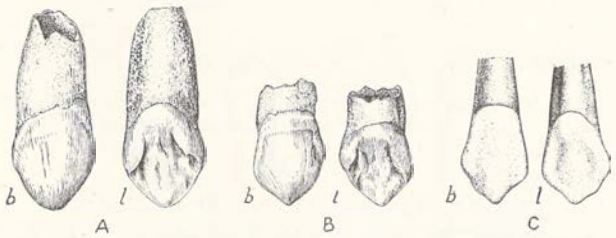

FIG. 13.—Upper canines—*b*, outside; *l*, inside—from Sinanthropus pekinensis, large type of tooth (*A*); small type of tooth (*B*); and modern European (*C*). ×1/1.

and do not show signs of a definitive approach to special patterns of recent anthropoids (cf. Weidenreich, 1937). It is true that both the upper and lower canines of Sinanthropus are distinctly larger and more projecting than those of modern man, but they do not have the size, and still less the characteristic form and pattern, of modern anthropoid canines (Figs. 13 and 14). The lower canine of Sinanthropus more closely resembles an incisor than an ape canine (Fig. 14) and recalls the conditions of presimians rather than those of anthropoids. On the other hand, the canine of a fossil orangutan (Fig. 14, *Ab*) found in a cave in southern China resembles the form of the human canine (*Ba*, *b*) more than that of the modern orangutan or chimpanzee (*Aa*). In addition, the fact is well known that the anthropoids, especially the chimpanzee (Fig. 15, *A*), display a great variability in size and pattern of canines and first lower premolars and in some

cases come very close to the conditions of man (Fig. 15, *B–F*). All this suggests that the tooth pattern of the original common stock may have been retained in man, while the anthropoid branch has produced special differentiations.

Furthermore, the relation of the length of the arm bones to that of the leg bones in man and anthropoids is another example of the differences between man and anthropoid. When an-

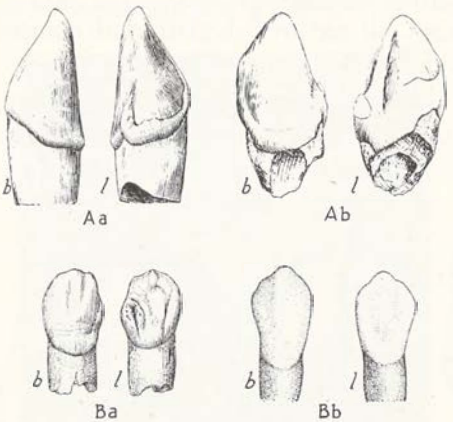

FIG. 14.—Lower canines—*b*, outside; *l*, inside—from chimpanzee (*Aa*); fossil orangutan (*Ab*); Sinanthropus pekinensis, small type of tooth (*Ba*); modern European (*Bb*). ×1/1.

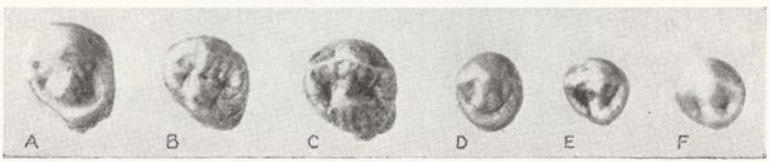

FIG. 15.—First lower premolars from chimpanzee (*A*); Sinanthropus pekinensis (*B* and *C*); modern man (*D–F*). ×1/1 approximately.

thropoid and man stand or walk on all fours (Fig. 16), the shoulders mark the highest elevation of the back line in anthropoid (*A*), while the hips take this place in man (*B*). The arm bones of the orangutan are 144 per cent longer than its leg bones; those of the gorilla, 117 per cent longer; and those of the chimpanzee, 109 per cent; while the leg bones of man are 30 per cent longer than the arm bones. These differences are shown in Figure 17, as far as the length of femur (*f*) and humerus (*h*) is con-

cerned. The length of these bones is about the same in the chimpanzee (*A*), whereas in man (*C*) the femur considerably exceeds the humerus. Although Sinanthropus has furnished only fragments of the two bones in question, their reconstruction (*B*), though not strictly accurate, shows the proportions of the upper and lower limbs to be the same as those of modern man (*C*) and certainly unlike those of the anthropoids (*A*) (cf. Weidenreich, 1941*a*). Therefore, it is not probable that the intermembral pro-

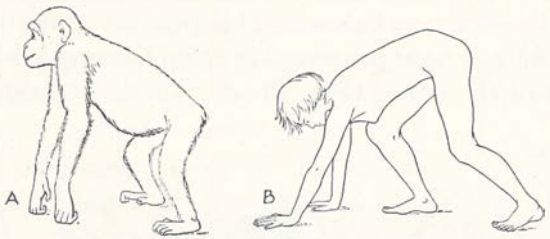

FIG. 16.—Chimpanzee (*A*) and man (*B*) walking on all fours. Note the differences in the length of the hind limbs in relation to the forelimbs.

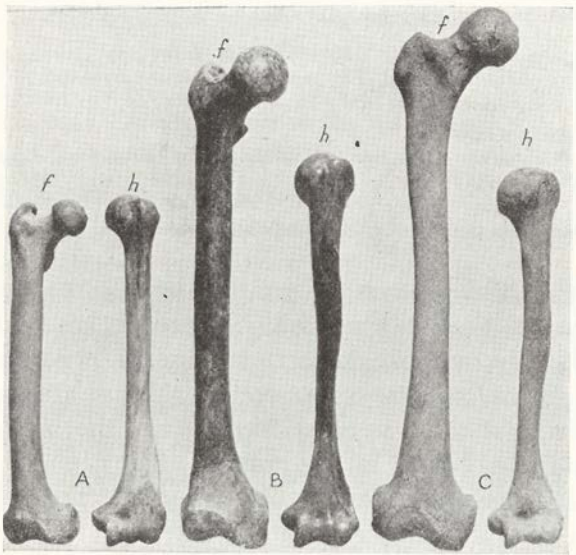

FIG. 17.—Femur, *f*, and humerus, *h*, of chimpanzee (*A*), Sinanthropus pekinensis (*B*), and modern man (*C*). The length of the two bones is about equal in the chimpanzee, while the femur of early and recent man considerably surpasses the humerus.

portions of the common anthropoid ancestor were like those of the living orangutan or gorilla and that man has reduced the length of his arms to such a degree.

The principal structure of the human foot reveals all the peculiarities of a genuine climbing instrument (Weidenreich, 1921–22). When an anthropoid stands upright (Fig. 4), only the heel and the lateral margin of the foot up to the tip of the fifth toe touch the ground. The other parts of the skeleton remain above the ground (Fig. 18, *B*), and the maximum abduction of the big toe keeps the body in balance. This primary condition of the climbing foot has been preserved in man, as revealed by the arrangement of the bones (Fig. 18, *A*). The heel and the lateral

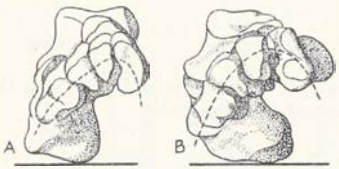

FIG. 18

FIG. 19

FIG. 18.—The arrangement of the tarsal bones of the right foot of man (*A*) and gorilla (*B*), viewed from the front. The metatarsal bones are removed. Note the steep rise of the individual bones from lateral to medial, as indicated by the curved, broken line.

FIG. 19.—Right human foot (after G. Mollier). The lateral part of the foot alone rests upon the ground; the medial is superposed on the lateral. The medial metatarsal bones descend to reach the ground with their heads. Compare this arrangement with the conditions of the foot of a chimpanzee in erect position (Fig. 4).

bones of the tarsus rest on the ground and so form the base for the superposed medial bones, which, however, are held in their position largely by muscular action alone. In accordance with the abduction of the entire extremity which characterizes the erect position of man, as mentioned before, the big toe is adducted and immobilized in this position (Fig. 2, *C*). The medial metatarsal bones decline toward the ground to keep abreast of the lateral ones. All this brings about a twist in the structure of the foot skeleton, which can be seen even when all the flesh is on (Fig. 19). An x-ray photograph of any human foot (Fig. 20) reveals, furthermore, that the heads of the four lateral metatarsal

bones and the head of that of the big toe are still facing each other, recalling their opposition in the original climbing foot. The extent and manner of the adaptation of the human foot to standing and walking conditions indicate that this process must have set in during a very early phase, long before the three anthropoids could have a claim to their present names.

All that is known thus far of the bodily organization of early man proves that his trunk and limb bones had already acquired human proportions when the conditions of his skull and the size of his brain case were still close to those of the anthropoids. This suggests that the original simian type from which man and the three anthropoids branched off showed more of the human organization than that of orangutan, gorilla, or even chimpanzee of today. It is not necessary to assume that the orangutan, the most specialized of the three, was the earliest to separate and the chimpanzee, the least specialized, the latest. Differences in the degree of differentiations can just as easily be the result of an accelerated process in one case and a retarded one in the other.

FIG. 20.—The skeleton of the metatarsus and the toes of a left human foot as it is shown in an x-ray photograph. The toes are bent at their maximum. The heads of the four lateral metatarsalia and that of the big toe face each other. (After H. Virchow.)

Anthropologists used to speak of primitive characters of early man, equating primitive with anthropoid-like and anthropoid-like with gorilla- or chimpanzee-like. This is misleading and, indeed, has led to misunderstanding and misinterpretation. It is not necessarily so that each peculiarity displayed in early man occurs in anthropoids. It may represent a human specialty which demonstrates the early independence of man's development.

Our information about the early phases of man is not so good as we would like it to be. But it is incomparably better than that which we have regarding anthropoids. For, in the latter case, the most informative material available consists almost exclusively of fragments of jaws and teeth. There is a great variety of fossil

forms, which have been described under many different names, such as Dryopithecus, Sivapithecus, Proconsul, and others. All of them are considered by the authors as forerunners of the living anthropoids: Proconsul, from eastern Africa, as the ancestor of the chimpanzee; Sivapithecus, from India, as that of the orangutan; Dryopithecus, dispersed over the whole Old World and split into a great many types, as ancestor of the gorilla or perhaps of all three living anthropoids. However, none of these types differs in its basic structure from the anthropoids of today or shows any definite approach to man, neither modern nor earlier types. Since only jaws and teeth of these fossils are known, all comparison must rest on these parts of the skeleton. Nevertheless, they are sufficient to demonstrate that the form of the dental arch, the character of the canines and the first lower premolar, and the special pattern of the lower molars are, in principle, the same as those of modern anthropoids. The lower canine and the first premolar of Dryopithecus cautleyi and fontani (shown in Fig. 21) are of the tusk-like and sectorial types, respectively, as are those of any living anthropoid (Figs. 5; 6, *A*). This suggests that the whole Dryopithecinae group was already specialized in the direction of the living anthropoids. Should discoveries of other parts of the skeleton corroborate this statement, it would have far-reaching consequences with regard to the estimate of the geological age of man. The Dryopithecinae are typical Tertiary forms, some of them going back to the Miocene. The specialization of their dentition was apparently already achieved at a very early time. Consequently, the human branch, which did not participate in this development, must have managed its separation from the Dryopithecus stem, lead-

FIG. 21.—Lower canine and first lower premolar of Dryopithecus cautleyi (*A*), and Dryopithecus fontani (*B*), viewed from the outside. (After W. K. Gregory and M. Hellman.)

ing to the modern anthropoids, in the Miocene or not very long afterward. In other words, the evolution of that primate branch which we call "man" must have begun much earlier than we ever dreamed.

There are still other indications that man cannot be the product of a relatively late development, going no farther back than Lower or Middle Pleistocene. We shall return to this question in chapter iii. But I want to emphasize in this connection that an early development of highly specialized primate types is suggested by observations which were made many years ago, though this special implication escaped realization. In 1892 a well-preserved thighbone was recovered near Mayence, in the valley of the Rhine. It was recognized as the bone of a primate and was called Paidopithex because of its resemblance to a human child twelve years of age. In reality, the bone does not differ either in form and proportions or in details from the thighbone of the living siamang, the big gibbon of Sumatra and the Malayan Peninsula. The only differences are two: the size (the fossil ape was a giant, compared with the present form) and the fact that Paidopithex lived in central Europe as early as the Lower Pliocene. Another example: In Choukoutien, skeletons of macaques and baboons have been found in the same locality that yielded Peking man, but these monkeys do not differ from living forms of the same family except for their greater size. Therefore, monkeys and apes had finished their specialization, on the whole, at a time when the finishing touches, namely, the transformation of the skull and the ultimate development of the brain, still remained to be applied to man. The adoption of erect posture and the corresponding transformation of foot and limb bones, obvious prerequisites of the transformation of the skull, must have been achieved much earlier.

So far, only those fossil anthropoids have been discussed which agree with the living ones in dentition and form of the dental arch but differ in those same features from man and his whole evolutionary line. However, in recent years other fossil types have become known which are like the gorilla and the

chimpanzee in their entire appearance but reveal remarkable differences in some of the details. The first of these forms, found and recognized by R. A. Dart, came from the Pleistocene of southern Africa. It goes under the name Australopithecus africanus (Fig. 22). The greater part of the skull—brain case and face, including the lower jaw—has been preserved; but, unfortunately, the specimen is a child corresponding in age with a modern human child of about six years. This makes a correct classification difficult, because classifications of this kind are generally based on adult specimens. In late years our knowledge of these anthropoid types has been considerably advanced by R. Broom, who recovered several adult specimens of a similar type. These specimens were found, like the original Australopithecus, in the Pleistocene of southern Africa but came from other localities. They consist of fragments of skulls with jaw and teeth; also, some fragments of limb bones have been found. Broom distinguished two forms, which he called Paranthropus robustus and Plesianthropus transvaalensis, stressing by these names their close relationship to man.

If the morphological criteria which I consider as decisive for the distinction of man and anthropoids are applied to these Australopithecus types, the diagnosis is not easy, for the latter combine human characters with simian ones in a way which has never been observed before. The skull as a whole and the relation between the size and position of the brain case and face do not differ from the condition in anthropoids, particularly from that in the gorilla. But the dentition is surprisingly manlike: the canines are small, the first lower premolar is not of the sectorial type, and there is no gap between the upper lateral incisor and the canine. Figure 23 shows the upper jaw of Plesianthropus transvaalensis in lateral view. The teeth, from right to left, are: lateral incisor, canine, first premolar, and first molar. The second premolar is wanting. A comparison of this upper jaw with that of Pithecanthropus (Figs. 47 and 50) reveals the similarities and dissimilarities in the dentition of early human form and the Australopithecinae. The form of the dental arch of the Australopithecinae seems more like that of man than that of apes.

In addition, the jaw joint and the bones which surround the ear aperture show strikingly human characters and certainly not simian ones. Unfortunately, little is known of the limb bones. Dart believes that Australopithecus had already acquired an upright posture. Yet his conclusion is drawn not from anatomical facts but from circumstantial evidence. Crushed bones of small animals, among them skulls of baboons, and cracked shells found in the same cave as the Australopithecus skull suggested to Dart that Australopithecus "was an animal-hunting, flesh-eating, shell-cracking and bone-breaking ape." This would cer-

FIG. 22

FIG. 23

FIG. 22.—Australopithecus africanus Dart. (Photograph taken by R. A. Dart.)

FIG. 23.—Upper jaw of Plesioanthropus transvaalensis Broom. The teeth from right to left are: second incisor, canine, first premolar, first molar. The second premolar is not preserved.

tainly be a strange habit of nutrition and life for an ape and, of course, only feasible if the hands have been freed from locomotion. Broom found an ankle bone of Paranthropus which, according to him, looks more like that of man than that of an anthropoid. But, in view of the scantiness of the material, it is safer to postpone definitive judgment on the zoölogical character of the Australopithecinae until more material will be available. In any case, it can be said without risking revocation that this southern African group of fossil anthropoids is closer to man than any living or fossil anthropoid form known thus far.

Decision about the precise relation of the Australopithecinae to man is more difficult. They may represent a group ancestral to

man. Or they may represent a simian group, parallel to the anthropoids, which finally merged into the latter. Or, as a last alternative, they may represent a special, differentiated group which left no descendants behind. I am of the opinion that they are not in the human line but are a special group which has preserved some of the original characters of the common stock from which man, as well as the other anthropoids, originated. These characters have been lost by that group which differentiated in the direction of the living anthropoids, while they have been maintained and perfected in the line which led to man.

Besides the southern African forms, other short-snouted anthropoid types have been discovered among the fossil anthro-

FIG. 24.—Reconstruction of the brain case of the Piltdown man. The added parts in lighter tone. (After H. F. Friederichs.)

poids of India. Their dentition is insufficiently known, but they may somehow be connected with the southern Africans. In this connection, another fact should be considered. We know of a lower jaw from the Lower Pleistocene of southern England which is anatomically, without any doubt, the jaw of an anthropoid. The trouble is that this jaw, although generally acknowledged as a simian jaw, has been attributed to man because it was found mixed with fragments of an undoubtedly human brain case. I am referring to the famous Piltdown finds and to Eoanthropus, as the reconstructed human type has been called by the English authors. Figure 24 shows the brain case reconstructed strictly on the basis of the morphological character, as exhibited by the preserved fragments; Figure 25 is the lower jaw,

reconstructed according to the same principle (Friederichs). Form and individual features of the brain case are generally acknowledged as those of modern man; those of the lower jaw, as anthropoid characteristics. Therefore, both skeletal elements cannot belong to the same skull. All that has been known of early man since the discovery of the Piltdown fossils proves that man cannot have had an ancestor with a lower jaw of a completely simian character. The "missing links" the anthropologists of early days had in mind were not chimeras but forms harmoniously fitting in between man and apes. In all finds in which subsequent accidental mixing-up of fragments could be excluded, disharmonies like those of the Piltdown case have

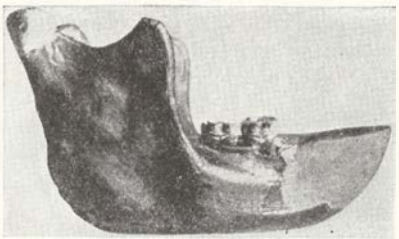

FIG. 25.—Reconstruction of the lower jaw of Piltdown man. The added parts in lighter tone. (After H. F. Friederichs.)

never been noted. Rather the reverse conditions, namely, a human jaw with human teeth and a more apelike brain case, have been observed (cf. the Mount Carmel skull, Fig. 41).

The two anthropoid groups, the more human-like Australopithecinae and the less human-like Dryopithecinae, seem to have been distributed over great parts of the Old World, as was the human group itself, each evolving in its own direction, once the separation had set in. But only the human and the less human-like groups had the ability to survive.

Just as the three living anthropoids differentiated as a unit from the common stock, so did man. There are indications that man was not totally uniform in the beginning but varied in minor characters. Yet, as is the case in anthropoids, these differences did not affect his fundamental human organization. I do not believe that anyone who is familiar with either the anat-

omy of the anthropoids, on one hand, or that of man, on the other—living and fossil forms alike—will disagree with this statement. Thirty-five years ago, Klaatsch took up an older idea, according to which the different main races of today have derived from the three anthropoid stocks: Negroes from the gorilla, Mongolians from the orangutan, and whites from the

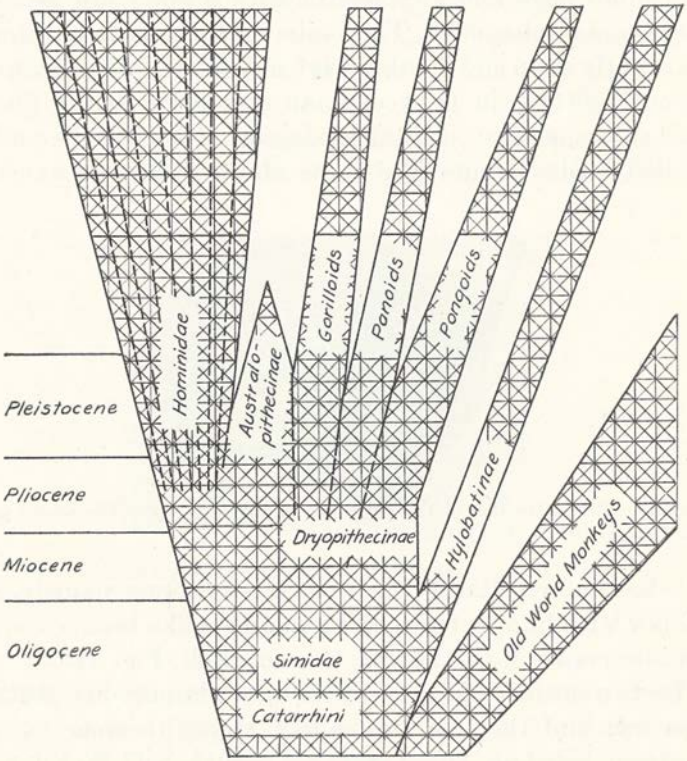

FIG. 26.—Family tree of the hominid-anthropoid stock of the primate order. (For details see text.)

chimpanzee. Klaatsch came to these conclusions because he found similarities between the limb bones of these anthropoids and the mentioned races of modern man. Nobody took Klaatsch seriously, the less so as he later withdrew his former statement more and more. Only Crookshank made the attempt to support the theory by adducing new facts. He offered the odd idea that the Negroes sit down on the ground like the gorilla, with one leg

stretched and the other bent at the knee, while the way in which Buddha, the symbol of the Mongolians, is traditionally represented in paintings and sculptures recalls the sitting habits of the orangutan. This can certainly not be accepted as proof of consanguinity. The coincidence in the kind of curvatures of the long bones which Klaatsch claimed to have occasionally observed cannot obscure the fundamental differences in the proportions and structures of the limb bones, which are in all human races first human-like and in all anthropoids first anthropoid-like, despite any special features similar by chance. The origin of man was monophyletic, just as that of the three anthropoids was when compared with the origin of other subbranches of the primate stem. Such a statement does not exclude the possibility that interbreeding took place before the separation of the different types was completed. Early crossing may have transmitted special traits from one type to the other, even if one type showed the beginning of human differentiation and the other the beginning of anthropoid differentiation.

Family trees are the usual graphic expression of relationship between different groups which branch off a common stock. Although those constructions are very hypothetical, they give a good idea of an author's interpretation of the available facts. The diagram presented in Figure 26 departs from the usual form of those pedigrees. An attempt has been made to indicate, also by graphic means (crosslines), the obvious tendency of the listed forms to exchange specific acquired features. The first appearance of special differentiations within a still undivided group is marked in a similar graphic manner (vertical broken lines). The geological periods in which those differentiations presumably took place are noted at the left of the diagram.

CHAPTER II

THE DEVELOPMENT OF THE SPECIFICALLY HUMAN FORM

> As the progenitors of man become more and more erect, with their hands and arms more and more modified for prehension and other purposes, with their feet and legs at the same time transformed for firm support and progression, ... the pelvis would have to be broadened, the spine peculiarly curved, and the head fixed in an altered position, all of which changes have been attained by man.
>
> —CHARLES DARWIN, *The Descent of Man*

WHEN an attempt is made to range all specimens of fossil man according to the degree of their morphological age, ten easily distinguishable phases can be established. These seem few when compared with evolutionary lines of other mammals; but when we realize that for many years the so-called "Neanderthal man" was the only fossil form which was recognized as possibly ancestral to modern man, the progress appears enormous. This increase is due in great part to the discovery of completely new types and in some part to a better understanding of the morphology of forms long known but not fully comprehended, or even misinterpreted. The history of Java man is the best example for demonstrating the extent to which new discoveries can dispel doubts. The first skull (Fig. 27, *A*), consisting only of the cap, was collected in 1891 by Eugène Dubois near Trinil in central Java (map, Fig. 61). At first its discoverer considered the skull that of a chimpanzee, but he soon corrected this classification. In 1894 Dubois described the fragment as a real missing link and called the type, for this reason, Pithecanthropus, that is, "ape man." Some scientists agreed; others, more critical, continued to regard the fragment as that of a true ape, although with giant proportions. How far this opposition has influenced Dubois's judgment is unknown; but, in any case, in later years and until his death in 1940 Dubois clung to the idea

that Java man was a giant gibbon, which, although different from any true anthropoid, finally transmuted into man.

The solution of the Pithecanthropus puzzle came in 1929, when the first skull of the Peking man came to light. This skull, which Davidson Black named Sinanthropus pekinensis, was more complete than the calotte from Java, which was broken off just above the ear (Fig. 28). In Sinanthropus the skullcap extends down almost to its base, the entire region around the ears being preserved. The new find did not leave the slightest doubt that Sinanthropus was a true man, although a very primitive type—in any case, more primitive than any of the long-

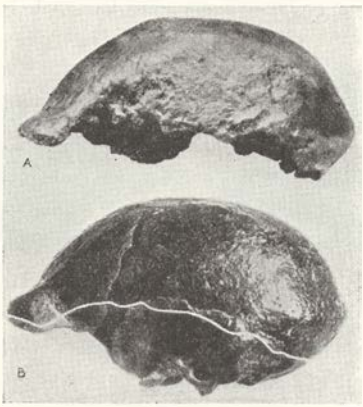

FIG. 27.—Skulls of Pithecanthropus erectus: *A*, skull cap of Trinil (Dubois); *B*, skull from Sangiran (Von Koenigswald). The Trinil specimen (*A*) is broken off along the white line (*B*).

known Neanderthalians. On the other hand, in its general form and size, the skull agrees with the Java skull to such an extent that it identifies Pithecanthropus, too, as a true man and a creature far above the stage of an ape. In 1938 R. von Koenigswald corroborated the correctness of this diagnosis by the discovery of a second Pithecanthropus skull (Fig. 27, *B*), this time almost as complete as the Sinanthropus skull (Fig. 28). This skull also came from central Java—from a locality, Sangiran (map, Fig. 61), not far from the site where Dubois had collected the first skull and, in addition, from the same geological horizon. The two Pithecanthropus skulls resemble each other as much as do two eggs (Fig. 27).

The finding of Sinanthropus pekinensis, now represented by fifteen individual skulls and skull fragments (cf. Weidenreich, 1943), and the finding of additional Pithecanthropus skulls, now totaling four (cf. Weidenreich, 1945*c*), were the first really decisive steps in our knowledge of early man after the discovery of the famous skullcap from Neanderthal, near Düsseldorf, made in 1859 (Fig. 29). As was the case with Pithecanthropus, the calotte of Düsseldorf was misinterpreted for many years. Although finds of similarly formed skulls had been made in Belgium and France and the well-known German anthropologist Schaafhausen and English anatomists like King recognized the fossil and specific character of Neanderthal man, leading an-

FIG. 28

FIG. 29

FIG. 28.—Skull *E* (Davidson Black) of Sinanthropus pekinensis. (Photograph by Davidson Black.)

FIG. 29.—The Neanderthal skull of Düsseldorf. (Photograph, Smithsonian Institution, Washington, D.C.)

thropologists continued to deny its specialty. Even as late as 1901, the skull was pushed aside by Rudolf Virchow, who denounced it as a pathological but ordinary human skull; some guessed that it might be the skull of a Russian soldier who found his death during one of the Napoleonic campaigns at the beginning of the nineteenth century.

Sir Arthur Keith (1925) introduced the term "neoanthropic man" ("near man") to designate the type represented by Linnaeus' Homo sapiens with all its variants, and the term "paleoanthropic man" ("ancient man") for Neanderthal man, the phase immediately preceding that of Homo sapiens. From this classification, only a small step is required to alter the terms in use and to designate all the groups or subfamilies represented by

these types as Neoanthropinae and Paleoanthropinae, respectively.

When Sinanthropus and Pithecanthropus are measured according to the characteristics of the Paleoanthropinae, they reveal new features which are not found in this group and, therefore, have to be classified as a more primitive subfamily, for which the name Archanthropinae ("primary man") seems to be adequate. The discoveries of recent years, however, have brought evidence that Sinanthropus and Pithecanthropus are not the only representatives of this primitive subfamily. Since 1939, more types have come to light which trace the human line a good deal farther back, beyond the phases of Sinanthropus and Pithecanthropus. Although the types recently found reach gigantic proportions and therefore complicate the classification, it seems justifiable to range them, at least tentatively, with the Archanthropinae. Considering the great importance of these new discoveries and the completely new aspect of the problem of human evolution which they open, the next chapter will deal with these goliaths and their relation to Sinanthropus, Pithecanthropus, and all the small human fry—fossil and modern, and in either case dwarfish, compared with the giants. Such a division of the material concerning the Archanthropinae is all the more justified, since, so far, only the giants have yielded skulls sufficiently preserved to make a comparison with the skulls of Paleoanthropinae and Neoanthropinae useful.

The accompanying chart (Fig. 30) is an attempt to group the fossils and their living hominid types according to their places in the evolutionary line (vertical differentiations) and their geographical specializations (horizontal differentiations). The vertical divisions represent ten evolutionary phases (I–X) so far distinguishable; they are listed according to their morphological sequence and by those names which were formerly assigned to them. The horizontal rubrics consist of four groups, corresponding, on the whole, to the geographical distribution of the main racial groups of today. The most primitive vertical group (Archanthropinae) is subdivided into five phases. Only one horizontal differentiation of this group is known. Three vertical phases represent the Paleoanthropinae, usually called by the collective

name "Neanderthal man." All classic Neanderthal types (horizontal differentiations) belong to the Eurasian group represented on the chart by the Palestinian Tabūn form. What is called "recent man" (Neoanthropinae) has been separated into two phases: the upper-paleolithic, which represents a more primitive type; and modern man. The horizontal differentiations of the

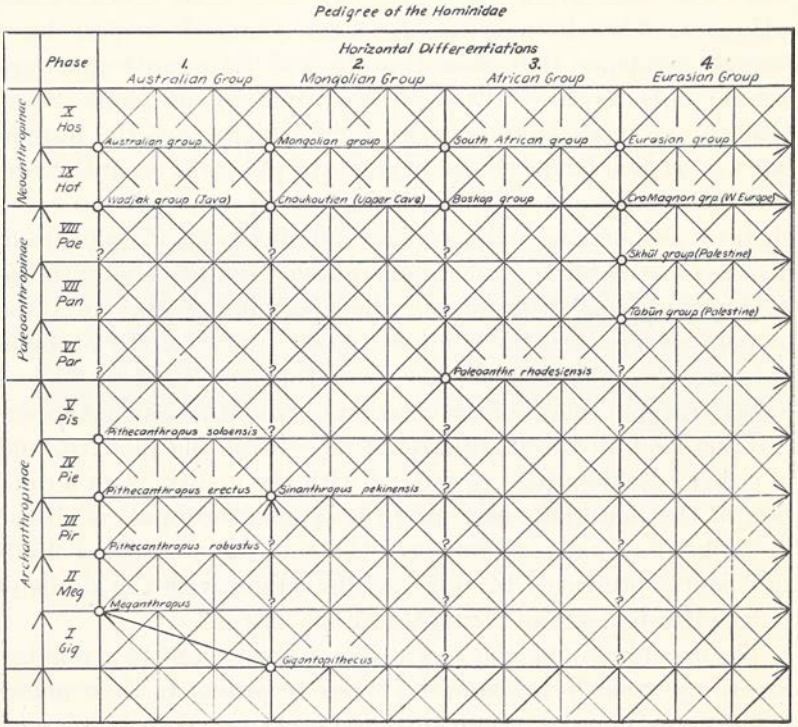

FIG. 30.—Chart illustrating the ten known, consecutive, evolutionary phases of man and their speciations. (For details see text.)

paleolithic forms are not identical with those of modern man (see chap. iv), although they come close to them morphologically. The vertical lines of the chart indicate, in all cases, ancestry; the horizontal lines, distribution and specialization; and the diagonals interchange, as a graphic presentation of the conception of the hominid group as one species. The many empty spaces, leaving aside the forms which have certainly preceded the first phase, reveal how little we know of the intermediate

forms which must be expected from what the known types indicate.

The last and decisive phase of human evolution concerns mainly the skull, as set forth in the preceding chapter. The relatively abundant skull material of these phases makes it possible to determine the basic character of the skull's transformation, the direction it has taken, and the chief factors behind its development. The skulls of Sinanthropus and Pithecanthropus do not differ from each other in their essential structures. It makes no difference, therefore, which one is chosen as prototype. Since the Sinanthropus skull is the better preserved and the more complete, it may serve as the standard type of an archanthropine

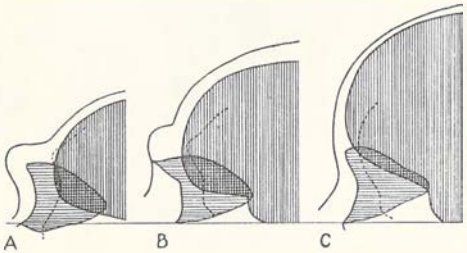

FIG. 31.—The topographical relation between eye socket and cranial cavity. *A*, chimpanzee; *B*, Sinanthropus pekinensis; *C*, modern man.

skull (Fig. 9, *B*). As racial differences are not essential in this case, a modern Chinese skull may be used as the prototype for the Neoanthropinae (Fig. 9, *C*). Since the archanthropine skull shows the basic characteristics of the human skull, its more primitive ancestor must have approached the simian state in a more definite way. I hope, therefore, that I may not be charged with too great a misrepresentation when I replace the unknown form of the supposed simian ancestor with the skull of a female gorilla (Fig. 9, *A*). However, it must be kept in mind that the whole face of the former, particularly the snout, was certainly much shorter and broader than that of its substitute.

The line, gorilla—Sinanthropus—modern man, reveals the fact that the brain case increased in size while the face became correspondingly reduced. Concomitant with this transformation, the brain case shifted frontward from its original position behind the eye sockets (Fig. 31, *A*) to one overlapping them

(Fig. 31, *C;* cf. also Fig. 11). The forehead rose more and more, correspondingly, while the face, especially the jaws, withdrew beneath the expanding brain case. A comparison of the three skulls (gorilla, Sinanthropus, and modern man) in frontal view (Fig. 32) and lateral views (Fig. 9) illustrates these changes. Another manifestation of this expansion is the increase of the skull

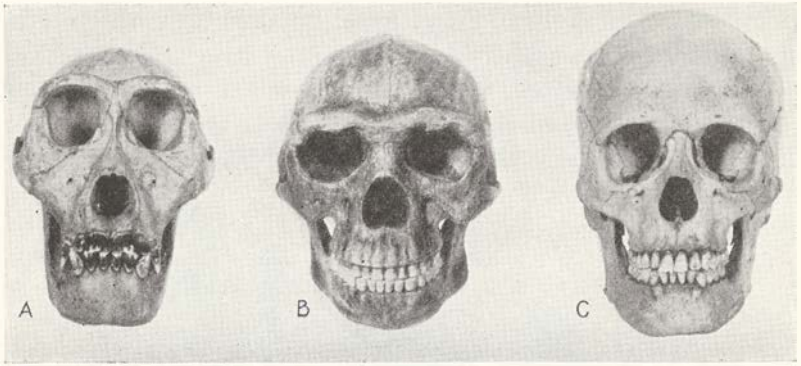

FIG. 32.—The three skulls of Figure 9 in front view

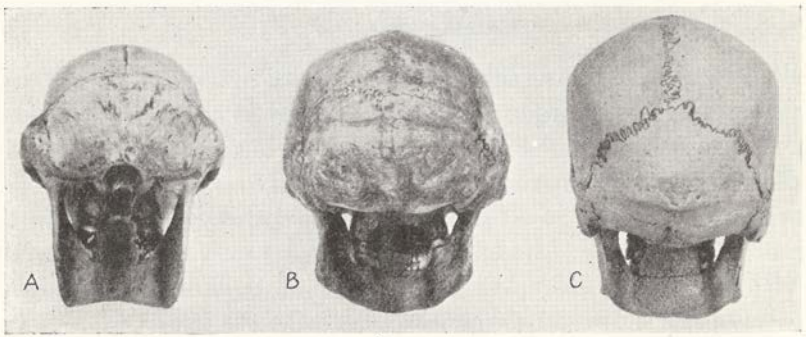

FIG. 33.—The three skulls of Figure 9 in occipital view

in height. The skull reached its greatest extension not in the frontal region, as was formerly assumed as almost self-evident, but in the region of the vertex and behind it. Simultaneously, the occiput moved downward and pushed, so to speak, the nape of the neck in the same direction. A look at the three skulls from behind (Fig. 33) shows this downward extension of the brain

case of modern man (*C*), when compared with the preceding evolutionary phases (*A* and *B*). The reduction of the jaws went hand in hand with a reduction of the chewing and cervical muscles (Fig. 9). The space required for the attachment of these muscles to the skull surface consequently became smaller, and so did the power of the whole chewing apparatus. The superstructures (cf. Fig. 10) which reinforce a primitive skull in the form of crests and ridges in front, rear, and on top, in order to

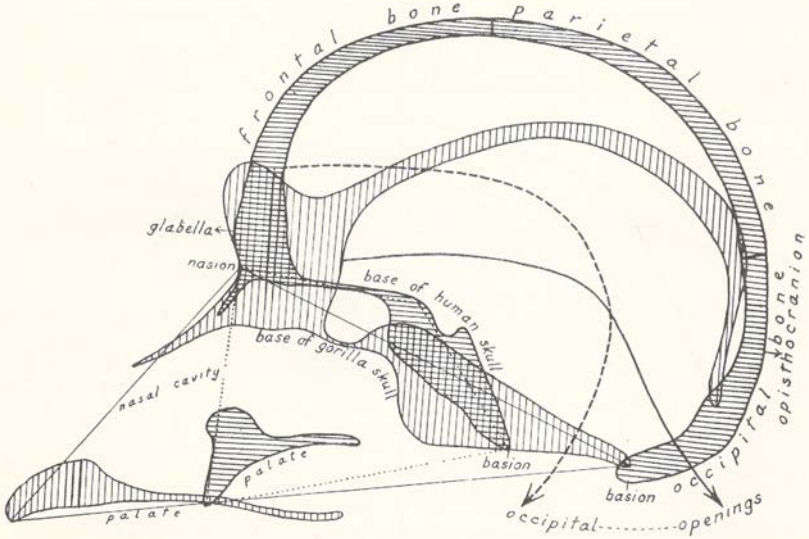

FIG. 34.—Mid-sagittal sections through the skulls of a male gorilla and modern man superposed on the eye-ear horizontal. Gorilla shaded by vertical lines, man by horizontal lines. (For details see text.)

enable it to stand the great strain of that mechanism, diminished correspondingly. All these changes can best be elucidated when the mid-sagittal sections through the skulls of modern man and gorilla are superposed, as shown in Figure 34. The human brain case has expanded forward, upward, and downward. This is concurrent with an alteration of the position of its occipital opening, which shifted from its original backward-directed position to one directed downward and even forward (see the curved lines and the arrows in both cases). Another essential consequence of this change, depicted in the same figure, is the

deflection of the base of the human skull (nasion-basion line). In the gorilla and even in early man, the base is straight (fine line), while in modern man (dotted line) its posterior half forms a marked angle ("saddle angle") with its anterior half. The reduction that the face has undergone is indicated by the two triangles (fine line and dotted line), which show to what extent the palate of man has receded in backward and upward directions, compared with the conditions in the great apes.

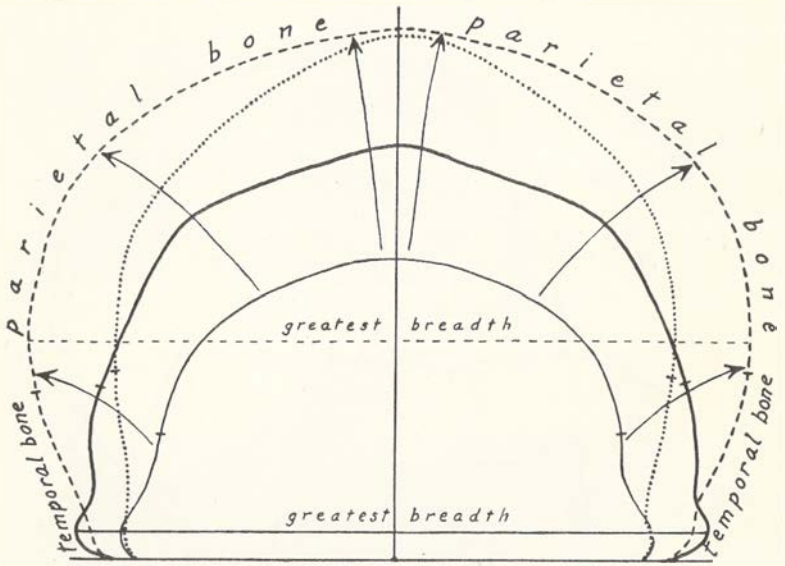

FIG. 35.—Transverse sections laid above the ear transversal through the brain cases of gorilla (*fine line*); Sinanthropus Skull XII (*heavy line*); dolichocephalic Australian native (*dotted line*); hyperbrachycephalic Austrian (*broken line*). The cranigrams show the growing expansion of the brain case in height and breadth. (For details see text.)

The breadth of the skull is influenced by the enlargement of the brain case in quite another way than the height (Fig. 35). The breadth at the base remains nearly unchanged—it even undergoes a slight contraction—but the skull becomes increasingly wider above the base. This alters the shape of the brain case very characteristically. The outline of a transverse section at the level of the ear apertures forms almost a triangle in early stages, while it approaches a circle in modern man, the greatest width having shifted to an area high above the base. As Figure

35 shows, there is practically no difference in this regard between an extreme dolichocephical (dotted line) and an extreme brachicephalic (heavy broken line) skull of modern man. In the latter case the sideward expansion is more pronounced, while the height remains about the same. The difference in breadth between a primitive human form and a modern one can best be recognized when the skulls are looked at from the rear (Fig. 33).

Viewed from the side (Fig. 9), the brain case of modern man appears in a more globular form than that of early man. The modern skull appears rolled up from the front to the rear, so that the posterior pole turns toward the anterior pole. Figure 36

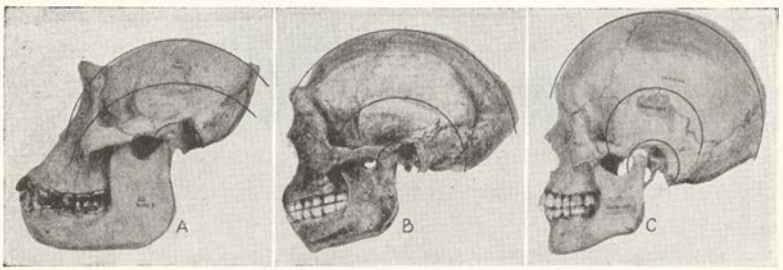

FIG. 36.—The three skulls of Figure 9 in lateral view. The three curves traced at three different levels—ear region, suture between temporal and parietal bones, mid-sagittal contour—demonstrate the growing tendency of the human skull to assume a globular form. (For further details see text.)

shows the extent of this transformation. On pictures of the three skulls (*A*, gorilla; *B*, Sinanthropus; *C*, modern man) taken from the left side, three curves have been drawn with the ear opening as their center. The innermost curve circles approximately around the tympanic bone; the middle curve follows the suture between the temporal and the parietal bone; and the outermost curve runs along the contour of the brain case itself from front to occiput. The three curves come nearest to a complete circle in modern man (*C*). Exaggeratedly expressed, the evolution of the human brain case proceeds like the inflation of a balloon; and it looks as though the enlargement of its content, the brain, were the driving factor.

It is surprising to observe the degree to which the individual

bones, even in their minor features, follow this general line of transformation. The transverse axis around which the skull is bent runs approximately through the jaw joints (Fig. 36). Thus the temporal bone occupies the central position in this phylogenetic shift. Whereas those bones which are situated at the periphery appear to be drawn out, the central ones, especially those immediately around the ear aperture, appear compressed together, compared with the initial stage. It is, of course, impossible to give a detailed description of all these transformations. Yet one of the most impressive experiences a student of human evolution can have is to realize the extent to which all the smaller structural alterations of the human skull are correlated with and dependent upon each other and the extent to which they are governed by the trend of the skull transformation as a whole. These details, which are scarcely recognizable when only the usual anthropological methods of measurement are applied and which have been badly neglected in the past, give clear evidence of the continuity of human evolution through all known phases (cf. Weidenreich, 1940*b*). All fossil human forms, from the most ancient morphological stage to the most advanced ones, show that the state of the minutest structure of the cranial bones corresponds in some way to that of the entire skull form and thereby proves that all forms must once have passed through the same principal phases, regardless of how far back this happened or how much time it has taken. As an example, the change of the occipital torus in extent, heaviness, and form is shown in Figure 37. The character of such details also provides the means for assigning each skull or skull fragment to its place in the evolutionary line and makes it possible to classify the various Neanderthal forms more precisely. There is not one detail which does not fit in the line and which could, therefore, be excluded as a type from the ancestry of modern man.

As to those cranial bones which deserve special attention, I would like to refer to the lower jaw; for lower jaws are not only the most numerous isolated bones among the finds of fossil man, but they exhibit one of the most conspicuous features contributing to the characterization of the early phases of human evolution—the absence of the chin. In the anthropoids (Fig. 6, *A*)

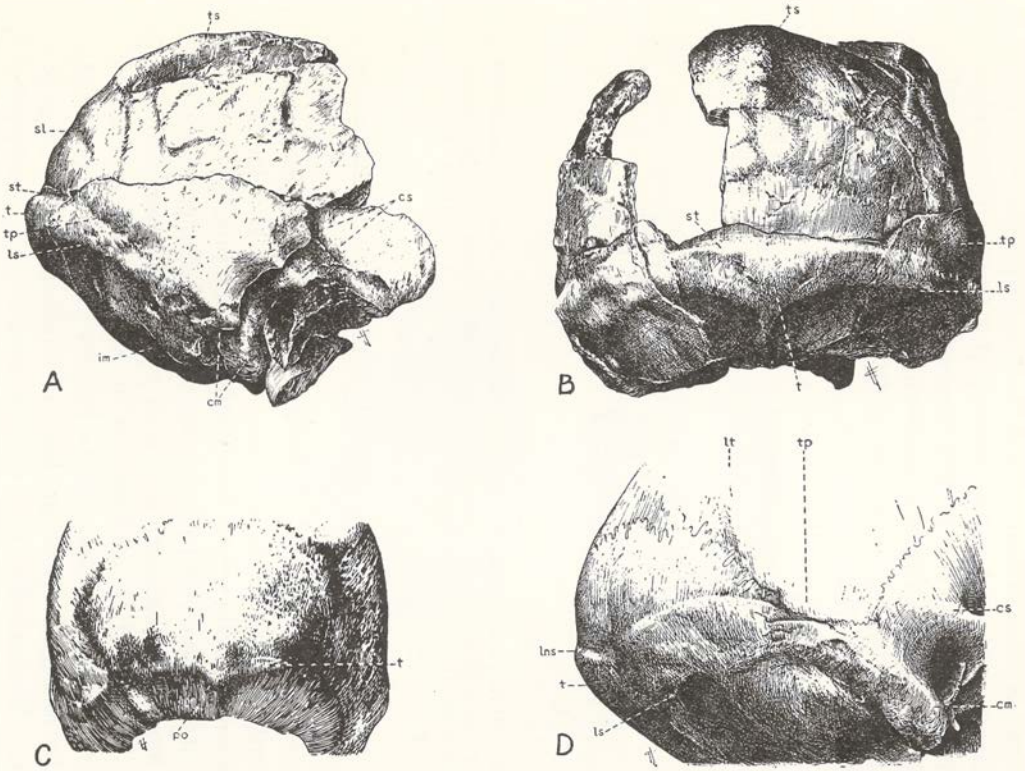

FIG. 37.—The appearance of the occipital torus in different phases of human evolution to show the way in which those superstructures of the brain case are reduced. Pithecanthropus robustus, lateral view (*A*); the same, occipital view (*B*); Paleoanthropine Steinheim skull (*C*); upper paleolithic skull—"Old Man"—of the "Upper Cave" of Choukoutien (*D*).

the basal portion of the jaw front recedes, while it projects in modern man (Fig. 6, *C*). The chin makes its appearance in man not earlier than between the penultimate and the final phases. Neither the Archanthropinae (Fig. 6, *B*) nor the Paleoanthropinae have a typical chin, thus raising this feature to the most indicative criterion of the modern human type (cf. Weidenreich, 1936). The conditions on the inner side of the chin region are quite different. Here, even the earliest recognizable human phase displays a pattern which anticipates the definitive human feature, as shown in the mid-saggital sections through the lower jaws (Fig. 38) of Meganthropus (*A*), Heidelberg man (*B*), Si-

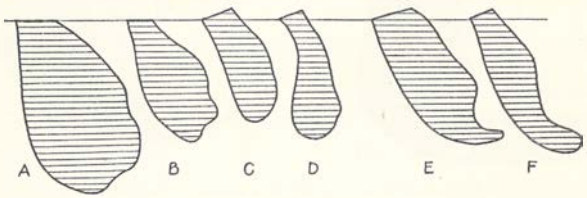

FIG. 38.—Mid-sagittal sections through the lower jaw (chin region) of human and anthropoid forms: Meganthropus paleojavanicus (*A*); Heidelberg man (*B*); Sinanthropus pekinensis (*C*); upper paleolithic man of Choukoutien (*D*); gorilla (*E*); orangutan (*F*). $\times\frac{1}{2}$.

nanthropus (*C*), and modern man (*D*), compared with the simian form (*E* and *F*).

The wide horseshoe form of the dental arch also appears relatively early in man. This is in accordance with the dentition. The famous Heidelberg jaw, for example, which puzzled the generation of its discoverer by its clumsiness and size, combines an almost modern human arch with nearly perfect human dentition (cf. Fig. 54, *C* and *D*, with Figs. 5, *B*, and 6, *C*). The teeth of Sinanthropus are also specifically human in their pattern and differ characteristically from those of anthropoids (cf. Figs 5, 7, and 13). Nevertheless, they exhibit certain very primitive details which can be traced back even beyond the anthropoid stage (Fig. 14). Their peculiarities undergo continuous alterations within the human line itself, which may best be characterized as a simplification of the pattern (Figs. 14 and 15). They thus permit us, together with the changes on the inside of the

chin, to put a given fossil human specimen in its right place in the evolutionary line.

When we review the different fossil human types following the Sinanthropus-Pithecanthropus stage, which has been chosen as a starting-point for this comparative survey, we note one type that is of the greatest significance. Unfortunately, it is still insufficiently known, although its discovery dates back thirteen years. This is the so-called Homo soloensis, found in central Java (Ngandong; see map, Fig. 61), not far from the locality

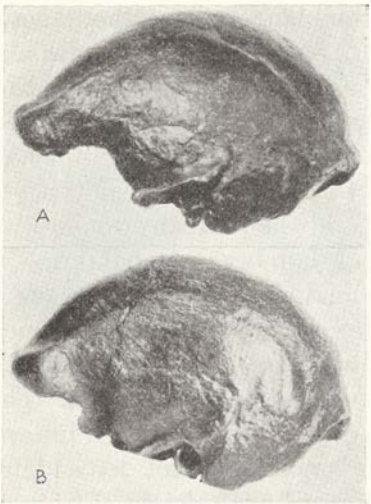

FIG. 39.—Skulls of Homo soloensis. Skull V (*A*); Skull XI (*B*)

where Dubois, forty years earlier, collected the skullcap of Trinil. No less than eleven skulls and skull fragments have been excavated there (cf. Fig. 39). Oppenoorth first described Soloensis man as a Neanderthal type, not differing much from the classic European form of this name. However, a study of the special features and their comparison with Sinanthropus and Pithecanthropus, on the one hand, and the various forms of the Neanderthal group, on the other, has revealed that Homo soloensis comes much closer to Pithecanthropus than to Neanderthal man (cf. Weidenreich 1943). Therefore, Homo soloensis can be classified as an archanthropine (chart, Fig. 30) with more justification

than as a paleoanthropine form. In reality, the Homo soloensis skull (Fig. 39) can be defined as an enlarged Pithecanthropus skull; its brain case (the face is not preserved) is much larger (average capacity, *ca.* 1,100 cc.) than that of Pithecanthropus (average capacity, *ca.* 860 cc.). But some of the primitive characters of the Pithecanthropus and Sinanthropus skulls, as well as some of the specialities of the Pithecanthropus skulls, have been retained in the Soloensis type to so great an extent that its association and relationship to the Pithecanthropus group is not questionable. On the other hand, the Soloensis skulls bear a strong general resemblance to the Rhodesian skull from southern Africa (Fig. 40). Since, however, the Rhodesian skull is more advanced in some features and approaches therein the skulls of the Neanderthal group, I have ranked the Rhodesian man with the paleoanthropines (chart, Fig. 30). But he is certainly more primitive than all the known European types of this group.

For many years all the paleoanthropines were regarded as a completely extinct group because no intermediate forms leading up to the modern human type had ever been found on European soil, although there was a continuous geological sequence and a sequence of cultural layers at all the sites from which representatives of both types had been recovered. The apparent break in the continuity of the forms has been interpreted as evidence that modern man is not the direct descendant of the Neanderthalian type but must have originated from another, unknown type. However, the discoveries of the Galilee skull of Palestine (A. Keith, 1927) and of the Weimar-Ehringsdorf skull from eastern Germany (cf. Weidenreich, 1928) indicated, despite their fragmentary condition, that such intermediates have existed. Indeed, when the Misses D. Bate and D. Garrod (1937), in cooperation with Dr. McCown, excavated the caves of Mount Carmel in Palestine, they at once disclosed the mystery of the origin of "Homo sapiens" (cf. McCown and Keith, 1939). They found a strange mixture of skeletons: those with all the characteristics of the Neanderthalian type and those with evidences of the Homo sapiens type but combined with heavily developed ridges over the eye sockets, which speak undoubtedly for their Neanderthal relations (cf. Skhūl V of the Mount Carmel popu-

lation, Fig. 41). No matter how the occurrence of such a mixture of forms may be explained, this find proves that the Neanderthalians (Fig. 29) did not die out but survived somewhere by continuing in "Homo sapiens."

There is no difficulty in tracing the Mount Carmel population to the man of today. The upper-paleolithic types of modern man recovered from Europe, Asia, Africa, and Java show all the desirable transitional forms. The skull of the male mammoth-hunter of Předmost in Moravia (Fig. 42, *A*), the male skull of a Magdalenian burial place (Obercassel) in the Rhine Valley

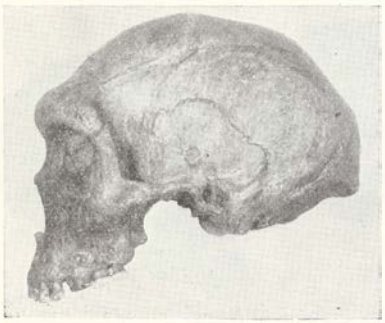

FIG. 40

FIG. 41

FIG. 40.—The Rhodesian skull.

FIG. 41.—Mount Carmel skull. Skhūl V. (After Theodore D. McCown and Sir Arthur Keith.)

(Fig. 42, *C*), and any of the male skulls of the Aurignacian cave deposits of Beni-Segoual in Algeria (Fig. 42, B) are especial examples of human types of this intermediate phase. Although each of these skulls exhibits characteristic signs of specialization (see chap. iv), the development and special structure of certain features prove that all belong to one group, ranging from skull types such as those of Mount Carmel to any modern human form.

In the Neanderthal or paleoanthropine phase, man did not reach his definitive form, so far as the transformation of the skull is concerned. Little is known about the development of other parts of the skeleton, but it can be taken as definitely es-

tablished that the erect posture and all that is connected with its adoption were attained long before that phase (cf. Weidenreich, 1941*a*). Thus, the subsequent change of the skull and, above all, that of the brain case, morphologically viewed, crowns the transformation in the true sense of the word, both in time and position.

One of the most interesting revelations brought about by the discoveries of the earliest human phases, as represented by Pithecanthropus and Sinanthropus, is the intimate correlation between the expansion of the brain case and the reduction of the jaws, with all the entailing changes of the special structures

FIG. 42.—Types of upper paleolithic skulls intermediate between skull types of Palestine (Fig. 41) and modern man: *A*, male individual of Předmost; *B*, a male skull of Beni-Segoual (Algeria) (after H. Vallois); and *C*, the male individual of Obercassel.

mentioned or alluded to earlier. This correlation and the way in which it becomes manifest are not phenomena of human evolution only but occur in the case of other mammals, also, when originally large forms assume dwarfish proportions. In such a case the starting forms, the end forms, and the intermediate ones are not necessarily phases of an evolutionary line but are variations in size of one and the same type. A perfect example is the domestic dog (Weidenreich, 1941*b*). Its large variations are represented by the wolfhound, the Great Dane, and the St. Bernard; its dwarf forms, by the Pekinese, the King Charles spaniel, and others. While there are no essential differences in the form of their skeletal bones, the skulls differ in structure, not in regard to their basic character as canine skulls, but as far

as the special form and shaping of brain case and jaw and their mutual arrangement are involved.

In the Irish wolfhound (Fig. 43, *A*), representing, so to speak, the giant race, the snout is elongated and pointed and takes up more than the anterior half of the entire skull, while the small cranial cavity (shaded area in Fig. 43) occupies only the posterior half of the skull. The superstructures of the brain case to which the chewing and cervical muscles are attached are strongly developed, and a large frontal sinus fills the space between the anterior end of the cranial cavity and the nasal cavity. The teeth are large and are like those of the wolf in number and general pattern. In the skull of the dwarf races (Fig. 43, *C*) the extent of the cranial cavity is almost identical with that of the skull itself, the face appearing only as an unimportant appendix of the brain case proper. Superstructures and sinuses have gone, the teeth are small, their number is diminished, and their pattern is simplified. The brain case, compared with that of the giant race, appears inflated like a balloon, while all the other cranial bones are reduced and dislocated correspondingly. The brain case has shifted to the top of the skull, and the face is placed beneath it. Races which are intermediate in size, like the bulldog (Fig. 43, *B*), also prove intermediate between the two extremes in regard to the appearance of brain case and face and their arrangement. Figure 44 shows the same skulls in vertical view.

The reason for these changes is obviously the expansion of the brain. The brain of the dwarf dog weighs only about 50 gm., while that of the giant dog is about 110 gm., or more than double. However, in proportion to the size of the body, the dwarf dog has a much larger brain than the giant dog: 1 gm. of the dwarf brain is correlated with 30 gm. of body mass, but 1 gm. of the giant brain with 350 gm. of body mass. Therefore, the skull of the dwarf dog is approximately one-tenth the size of the skull of the giant dog, but its brain is only half the size of the latter. In other words, the brain of the dwarf dog is much too large for the reduced skull and consequently needs for its accommodation all the space in the skull which can be made available. The result is the enormous expansion of the brain case in all its dimensions and the enormous diminution of the jaws and the teeth.

The principle of the correlations shown in races of the dog is exactly the same as that which is manifested in the phylogenetic transformation of the human skull. Figure 45, *A*, shows the skull of a male gorilla, as representative of a "giant" anthropoid form; (*C*) the skull of modern man, as representative of a

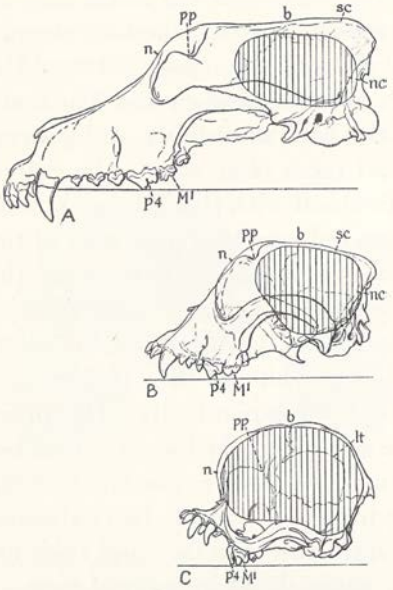

Fig. 43

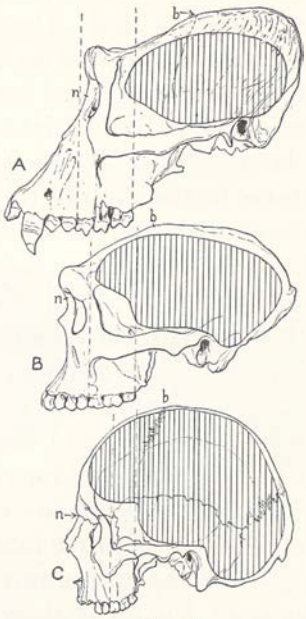

Fig. 45

Fig. 43.—Skulls of an Irish wolfhound (*A*), a bulldog (*B*), and a King Charles spaniel (*C*), in lateral view. The rate of reduction is the same for the three skulls. The cranial cavities are shaded.

Fig. 45.—Skulls of a male gorilla (*A*); Pithecanthropus robustus—reconstructed (*B*); and modern man (*C*), in lateral view. The rate of reduction is the same in all three skulls. The cranial cavities are shaded.

"dwarf" type of the anthropoid-human stock; (*B*) the reconstructed skull of Pithecanthropus (robustus), as representative of a form intermediate in size and structure between the two extremes (*A* and *B*). Figure 46 shows the same skulls in vertical view. The part of the brain case occupied by the brain is shaded in all the figures. There is, however, one striking difference between the anthropoid-human group and the dog races. Man cannot be considered a dwarf, nor the gorilla a giant when compared

with man. Maybe this view will have to be revised, to a certain extent, when more is known about the giant man of Java and southern China, which will be discussed in the following chapter. In any case, in the course of human evolution the human brain has increased not only relatively but also absolutely. The pri-

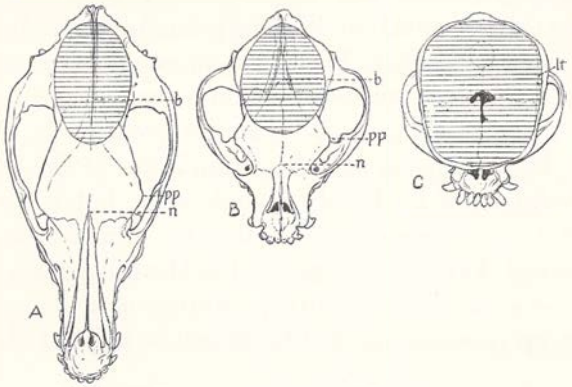

FIG. 44.—The same three skulls as in Figure 43, in vertical view

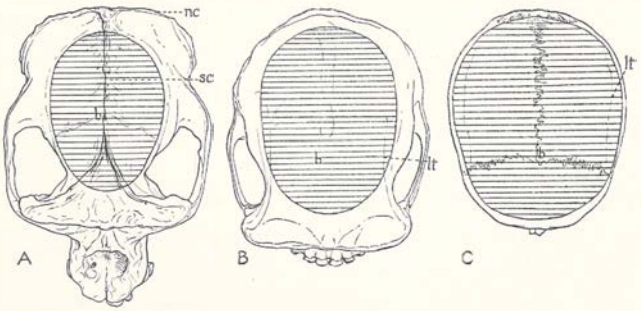

FIG. 46.—The same three skulls as in Figure 45, in vertical view

mary human brain case is provided only with the form and dimensions needed by an anthropoid, so to speak. These dimensions proved too small for the needs of man. To answer the requirements the brain case had to be enlarged. But the way in which this was done and the effect it had on the form, size, and mutual arrangement of the brain case and the face are identical in man and dog. This demonstrates clearly that human evolution followed a general biological pattern. The pattern, however,

can account for only the manner in which the skull reacted but not for the absolute enlargement of the brain itself, which has to be evaluated as a special achievement of man.

This consideration, based on studies of skeletal material of the earliest human fossils, leads to the same general conclusions at which Thomas Huxley and others arrived many years ago by comparing the organization of living primate forms. But there is one important difference: What was more or less a speculation in Huxley's time appears now as a fact proved by the fossil documents of the past. Man is the brainiest creature in the animal kingdom. The enlargement of his brain is one of the latest steps in the alteration of his bodily organization, but it reached the climax of its development only after the upright posture had been achieved. Yet, the enlargement of the brain mass is not the definitive step in man's evolution. Strange as it may appear, it is only its prerequisite, as will be shown in the last chapter.

CHAPTER III

GIANTS AS EARLIEST ANCESTORS

There were giants in the earth in those days.—Gen. 6:4.

ABOUT forty years ago some anthropologists believed that the first human being was a pygmy and that the pygmies of today are the relics of that first human type. Sometime later, a paleontologist discovered a Tertiary pebble on the beach of Antwerp which showed on the surface a strange system of parallel curved lines. He interpreted this pattern as a print left by the tip of the big toe of a man who once had taken a sun bath on the beach. The man's stature, he claimed, could not have exceeded 1 yard, calculated from the size of the area of the impressions of the big toe. Nobody took this "evidence" of the dwarf theory seriously.

The whole concept that the first man must have been a pygmy was originally based on the consideration that most mammalian orders came from small forms, which grew taller during phylogenetic evolution. However, living pygmies do not possess any true primitive features which make them different from taller races; nor do they represent a uniform morphological group, as the theory demands. They are local variations of quite different racial groups of normal size.

Moreover, even at the time that the pygmy theory was proclaimed, it could not be supported by any paleontological data. On the contrary, the only really early human form known at that time, Dubois's Pithecanthropus, had no dwarfish proportions but was considered as an especially tall type. For exactly this reason the main propagandist of the dwarf theory, the anatomist J. Kollmann, excluded Pithecanthropus from the human ancestry and pushed him to a side branch, supposed to have died out long before human evolution set in. This is a striking example of the extent to which paleontological facts were

disregarded and replaced with purely speculative constructions when evolution of man was the topic and when facts did not agree with preconceived ideas.

The irony of this history is that, from the same place where the deprecated Java man was recovered, evidence now comes that not dwarfs but giants were involved in human evolution. And it is a further irony that the most primitive and, in addition, the most unexpected and exciting human finds ever made come from a place which, despite Dubois's promising discoveries, has long been regarded by anthropologists of the old school as a forlorn outpost, not worth the trouble of search, so far as the scene of human evolution is concerned.

The new story of Java begins with the discovery of a second Pithecanthropus skull (Fig. 27, *B*), made by G. H. R. von Koenigswald in 1938. Reference was made in chapter ii to this find and to its significance for the whole problem of human evolution. Now, it must be added that this discovery was preceded, in 1937, by the finding of a fragment of a lower jaw (Fig. 47), the body of which was not quite so clumsy as that of the famous Heidelberg jaw (Fig. 54, *B* and *D*) but showed more primitive features. This jaw surpassed the Heidelberg jaw particularly in size and in the primitiveness of the teeth, but the teeth were undoubtedly human, nevertheless. It was natural to attribute this jaw to Pithecanthropus, although the two skulls then known—the first found by Dubois in 1891 (Fig. 27, *A*) and the second found by Von Koenigswald in 1938 (Fig. 27, *B*)—were much too small to lead one to expect an association between them and the big jaw and teeth.

In January, 1939, Von Koenigswald came to Peking, where I was working at the time, to study the jaw and the new Pithecanthropus skull with the help of the facilities of the Cenozoic Research Laboratory. When I met him at the station, I asked him whether he had, by chance, not brought a surprise. He answered: "Yes, I have. It is a big fragment of an upper jaw, just collected from Sangiran [Fig. 61 (map)] before I left Java. But it is still stuck in the matrix and, therefore, I am not sure whether it belongs to an ape or to a man." It soon was determined that it belonged to a man, but a man of unusual propor-

tions and unusual appearance (Fig. 47). The well-preserved teeth were, in general, bigger than the Sinanthropus teeth and those of the lower jaw of Pithecanthropus. But their pattern was undoubtedly human. The upper canines were small, compared with those of anthropoids, and projected slightly over the neighboring teeth. On the other hand, there was a wide gap on both sides between the front teeth and the canines (Fig. 50), such as is characteristic of the anthropoids and all lower apes and monkeys. In addition, the jaws projected to an extent and in a way never observed in man. An upper jaw with human teeth and a simian gap was certainly a novelty!

The jaw was broken off; but the breakage was fresh, indicating that this event must have happened not long before the specimen was found. So, there was also the possibility of picking up the associated skull. Instructions went to the Malayan collector, and after about four weeks of anxious expectations the missing skull arrived in Peking. This comprised the greater part of the brain case, the forehead, and the upper portion of the face, apparently having been lost long ago, and all covered with a big crust of matrix. When the specimen was cleaned, we had before us a skull which was badly crushed, obviously before any fossilization took place and again afterward, at a second time (Fig. 37, *A* and *B*). Nevertheless, what was left was sufficient to show that the new find was certainly a remarkable discovery, eclipsing all the previous Pithecanthropus finds.

Because the skull came from the same geological horizon as the other Pithecanthropus specimens and the outline of the well-preserved rear portion of the brain case resembled closely that of the first and second Pithecanthropus skulls, we did not hesitate to ascribe this skull to Pithecanthropus, although we were fully aware of the existence of striking differences, such as its greater size, the heaviness and special kind (Fig. 37, *A* and *B* [*t*, *ls*]) of its superstructures, and the massiveness and thickness of the bones, never before encountered in man (Fig. 48). Since those differences are common particulars in which male and female human skulls differ, we did what most comparative anatomists and anthropologists would do in such a case: we (Von Koenigswald and Weidenreich, 1939) interpreted the two small

FIG. 47

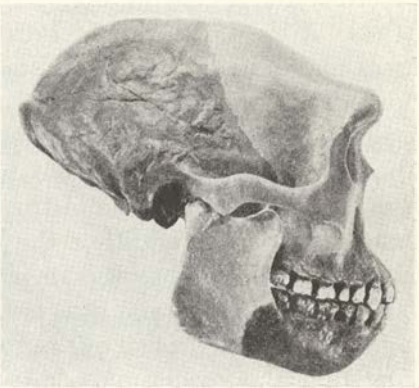

FIG. 49

FIG. 48

FIG. 50

FIG. 47.—Upper jaw of Pithecanthropus robustus and lower jaw of Pithecanthropus erectus adjusted in occlusal position. $\times\frac{1}{2}$.

FIG. 48.—Pithecanthropus robustus; floor of the cranial cavity. Note the thickness of the bones.

FIG. 49.—Reconstruction of the skull of Pithecanthropus robustus with the reconstruction of the lower jaw of Pithecanthropus erectus adapted. (With the kind assistance of Otto Falkenbach.) Right lateral view. The added parts in lighter tone.

FIG. 50.—The same reconstruction as in Figure 49. Frontal view.

types of Pithecanthropus (Fig. 27) as females and the new, big one as male.

But the satisfaction over this solution of the new Pithecanthropus puzzle did not last very long. In 1940, when I came to the United States, I made a reconstruction of the skull, with the kind assistance of Otto Falkenbach, of the American Museum of Natural History (Weidenreich, 1940*a*). The lower Pithecanthropus jaw, found in 1937, was reconstructed, too, and adjusted to the skull (Fig. 49, lateral view, and Fig. 50, frontal view). The whole character of the skull, as revealed in this reconstruction, aroused my doubts as to the correctness of our earlier diagnosis. About the same time, Von Koenigswald informed me that a fragment of a new type of lower jaw had been found at the same locality (Sangiran) that had yielded the big Pithecanthropus skull. Unfortunately, either some of the most characteristic teeth were totally missing or their crowns were broken off or worn down to such an extent that I could not risk a diagnosis, especially since I had only a cast on which to base my decision. Von Koenigswald regarded the jaw as human, but I was unable to come to any decision and preferred to leave it in abeyance until the original might become available. I doubt its human character and rather consider it an anthropoid—maybe a new short-snouted orangutan type (Weidenreich, 1943).

Early in 1941, I received a letter from Von Koenigswald in which he announced the discovery of a fragment of another lower jaw, collected at the same site as the jaw found earlier (Sangiran; see Fig. 61 [map]). But this time the critical teeth were still in their place and showed only slight attrition. A sketch of the piece was added. Von Koenigswald wrote that there could be no doubt that this jaw is a human one, although its proportions are enormous. I asked for a cast. It arrived just a couple of weeks after Pearl Harbor. It could be gathered from the label that Von Koenigswald intended to give the new human type, represented by this gigantic jaw, the name Meganthropus paleojavanicus, which means "giant man from old Java," and that he regarded the fragment as that of a male individual, while the fragment found earlier, not yet recognized, was attributed by him to a female individual of the same type (see Weidenreich, 1944).

The war in the Pacific severed all communications. What happened to Von Koenigswald was not known. But in view of the surprising turn paleoanthropology has taken through these discoveries, I considered it my duty to make the scientific world acquainted with them in order to prepare the way for a large-scale exploration of all the localities concerned when the war was over. Sure of Von Koenigswald's consent, I asked the representative of the Dutch government of the Netherlands Indies, the owner of the Java material, for permission to publish the results of my investigation. This permission has been granted. The

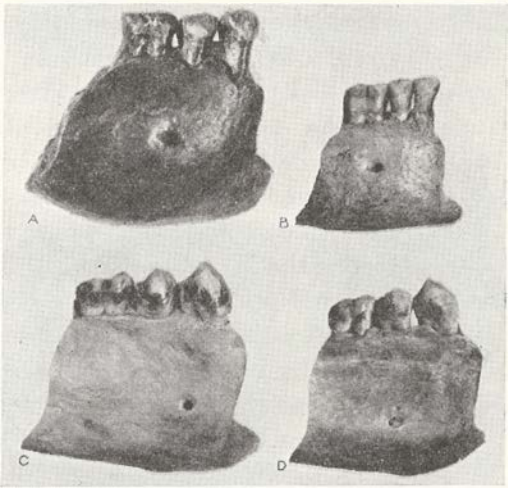

FIG. 51.—Fragments of the lower jaw of Meganthropus paleojavanicus Von Koenigswald (*A*), compared with a corresponding cut of a jaw of modern man (*B*); male gorilla (*C*); male orangutan (*D*). Lateral view. The rate of reduction is the same for all the specimens. $\times\frac{1}{2}$.

story I have now to tell is based only on casts and must, therefore, be checked against the original as soon as it is accessible.

The preserved piece of the lower jaw is only a small one; but, fortunately, it represents the most characteristic portion of the bone, so that its reconstruction has been possible. The most astonishing peculiarity, which strikes the eye first, is the size. The jaw far exceeds in height, as well as in thickness, any known fossil and modern human jaw, and likewise any jaw of fossil or recent anthropoids. Figure 51, *A*, shows the fragment from the

outside, with the three preserved teeth—from right to left: first premolar, second premolar, and first molar. Figure 51 shows cuts, from exactly the same part, of the jaws of modern man (*B*), male gorilla (*C*), and male orangutan (*D*). In Figure 52 the fragment is seen from above, occlusal view (*A*), compared with illustrations from modern man (*B*), male gorilla (*C*), and chimpanzee (*D*); and in Figure 53 it is viewed from below (*A*), together with illustrations of modern man (*B*), Sinanthropus (*C*), gorilla (*D*), orangutan (*E*), and chimpanzee (*F*). In all three figures the rate of reduction of the fragment and compared jaws

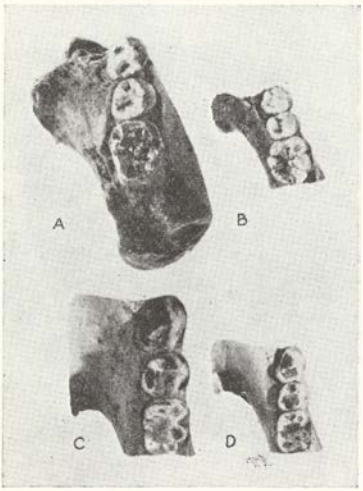

FIG. 52.—The same fragment as in Figure 51, *A*. Occlusal view. Modern man (*B*); male gorilla (*C*); male chimpanzee (*D*). ×½.

is the same; therefore, the illustrations give the real proportions. Even the jaw of the big male gorilla, though equal in height, has only about half the thickness of the new jaw. The thickness involves the front portion and the side parts alike. There is no chin or any hint of it (cf. Fig. 38, *A*). But the inside of this region shows the typical human pattern combined with some primitive characteristics, some of which have not been found, so far, either in man or in anthropoids (cf. Figs. 38 and 52). Since the fragment is broken off just beyond the mid-sagittal line of the jaw (Fig. 52, *A*), a reconstruction of the body of the jaw was

possible. It has been executed with the kind assistance of Otto Falkenbach, of the American Museum of Natural History. Figure 54 shows the reconstructed body in lateral (*A*) and occlusal (*C*) view. Figures (*B*) and (*D*) represent the Heidelberg jaw in the same views and with the same porportional reductions. The difference in the size of the bone, as well as of the teeth, is striking.

The human character of the jaw is, furthermore, testified by the teeth (Figs. 51; 52, *A*). These are enormous, corresponding to the dimensions of the bone. The canine itself is not preserved, but its

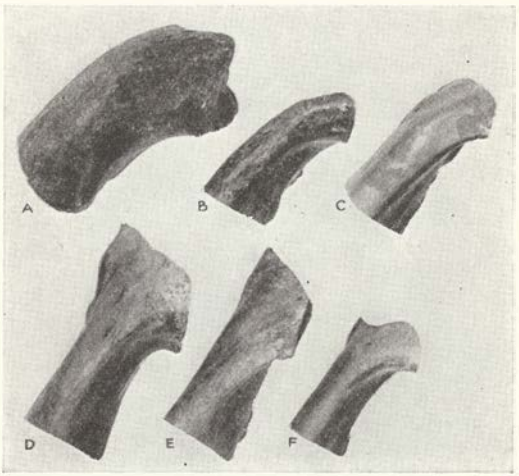

FIG. 53.—The same fragment as in Figure 51, *A*, viewed from below. Modern man (*B*); Sinanthropus pekinensis (*C*); male gorilla (*D*); male orangutan (*E*); male chimpanzee (*F*). $\times\frac{1}{2}$.

socket is. The size and form of the socket are as they are in man and are not like those in the great apes (cf. reconstruction of the canine in Fig. 54). In addition, the first lower molar is not of a sectorial type but shows the human pattern, with some features characteristic of early man (Fig. 51; cf. *A* and *B* with *C* and *D*). The form of the dental arch is intermediate between the human and the simian forms (cf. Fig. 54, *C*, with Fig. 54, *D*). The frontal curve is wide-spanned, and the side rows diverge, but much less so than in man; there is still a bend in the region of the canines.

The abnormal size of the jaw suggests that it may be a pathological specimen. In some giants observed in modern man the abnormal growth involves the lower jaw especially. This kind of giantism is called "acromegalic giantism" and is caused by a disturbance of the pituitary gland. However, in such a case, the alteration of the jaw is of a very different kind, in that the thickening concerns only the basal portion. The prominence of the chin, completely absent in the Java giant, is therefore exaggerated in acromegalic giants. The teeth, also, are different; they never participate in the pathological process but keep their

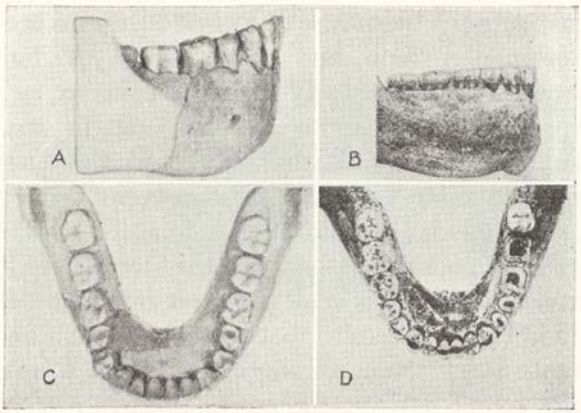

FIG. 54.—Reconstruction of the body of the jaw of Meganthropus paleojavanicus Von Koenigswald. (With the kind assistance of Otto Falkenbach.) The added parts in a lighter tone. *A*, lateral view; *C*, occlusal view; *B* and *D*, the corresponding views of the Heidelberg jaw. The rate of reduction is the same in all cases.

normal human proportions in acromegalic giants, while in the Java jaw they share in the giantism.

The thickness and massiveness of the Java jaw offer a clue to its relation to the other human fossils of the same locality. In the big skull with the large upper jaw and the gap between canine and incisor, found in 1939 at the same site and considered to be a male skull of Pithecanthropus (Figs. 49 and 50), the lower jaw is missing. The new giant jaw cannot belong to this skull or to the same type because it is too large for it. But there is another link. One of the most striking peculiarities of the cranial bones of that Pithecanthropus skull is their extraordinary thickness (Fig.

37, *A* and *B;* Fig. 48). The Java skull of 1939 is, indeed, the thickest human skull ever found. It exceeds the two other Pithecanthropus skulls as well as the Sinanthropus skulls, which already surpass any normal recent human skull and most of the fossil ones.

That the cranial bones of fossil man are thicker than those of modern man has been stated repeatedly. But, although this peculiarity has been used as a last resource when the fossil character of a find was in doubt, thickness and massiveness have hardly been realized as features typical of early man and lost in the course of evolution. The average thickness of all the bones which constitute the brain case of Pithecanthropus is double the average of modern man, and that of the Neanderthal man ranges between both. The early thickness concerns not only the cranial bones but also the facial bones, and in a still earlier phase also the lower jaw, as the Java giant now has revealed. Indeed, one of the most remarkable discoveries brought to light by the latest finds is the continuous reduction of the massiveness of the skull bones, together with the alterations of the skull (Weidenreich, 1943). This is all the more important since it reveals an additional difference between the human and anthropoid primate stock. None of the bones which form the brain case of any recent anthropoids are as massive as that of early man; they even scarcely reach that of modern man. At first sight, such a statement seems to be very objectionable when the skull of a male gorilla is thought of. Nevertheless, it is true, for the bones which constitute the wall of the gorilla's brain case itself are thinner than those of modern man. Either its seemingly massive bones are superstructures (Fig. 10), and so of secondary nature, or they are inflated by air; that is, they represent sinuses, while the bony substance is restricted to the walls of the thin sac that incloses the air.

The only skull bone which challenges the Java jaw in massiveness is the jaw of Broom's Paranthropus robustus from southern Africa (see chap. i). This jaw belongs to that strange group of Australopithecinae which shows the typical organization of anthropoids mixed with some human features. The species name, robustus, was given by Broom because of this extraordinary appearance of the jaw.

The robustness of the Pithecanthropus skull is the link connecting it with the giant jaw from Java, in addition to the agreement in primitive human traits shown by both. This suggests that there was a continuous line of gigantic and nearly gigantic human forms characterized by a gradual reduction in size, this reduction going hand in hand with a progressive trend in other features. For this reason I distinguish between the big Pithecanthropus skull of 1938 and the two earlier known, smaller skulls of Pithecanthropus. Their relation to each other cannot be considered as that of male to female, as assumed at first by Von Koenigswald and myself (1939). The big skull apparently repre-

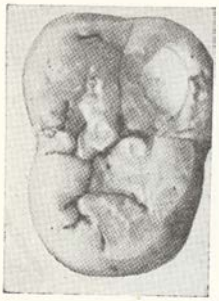

FIG. 55

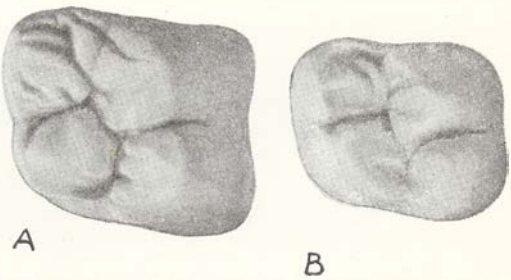

FIG. 56

FIG. 55.—Third lower molar (left) of Gigantopithecus blacki Von Koenigswald. (After G. H. R. von Koenigswald.) Occlusal view. ×2.

FIG. 56.—Upper molar (right) of Gigantopithecus blacki Von Koenigswald (*A*); the same tooth of modern man (*B*). Occlusal view. *A*, ×1½; *B*, ×2.

sents a special type already on the way to giantism; therefore I gave it the name "Pithecanthropus robustus" (cf. Fig. 30 [chart]).

When I arrived at this concept, I remembered that I had in my dubious material the casts of three isolated teeth of gigantic dimensions which Von Koenigswald had given to me in the last few years. These teeth came from a site which is usually not a source of fossil bones: they were picked up by Von Koenigswald out of cupboards of Chinese chemists' shops in Hong Kong. Fossil bones and teeth are commercial articles in the Far East and are widely used in medical preparations against all kinds of diseases. In 1903 a fossil tooth recovered in the same way in a dispensary in Peking was later recognized by the German pale-

ontologist Schlosser as a human tooth. This tooth was not an immediate help because it was badly worn. However, it indicated the presence of early man in northern China, confirmed twenty-five years later by incontestably human fossil material found in Choukoutien.

The tooth that attracted Von Koenigswald's attention by its enormous proportions was a third lower molar with the roots broken off and the crown badly worn, yet with the pattern of the chewing surface sufficiently preserved to determine the general character of the tooth (Fig. 55). Von Koenigswald recognized that this was the tooth of an anthropoid type; but, since it did not show any relation to known types, he described it (1935)

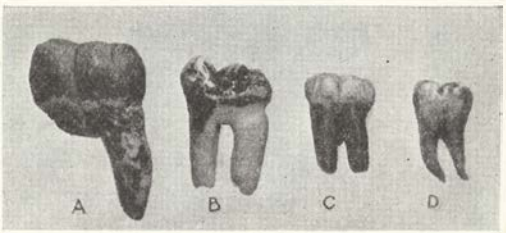

FIG. 57.—Third lower molar (right) of Gigantopithecus blacki Von Koenigswald (*A*) compared with the same tooth of a male gorilla (*B*); a first lower molar of Sinanthropus pekinensis (*C*); and the same tooth of modern man (*D*). Lateral view. The rate of reduction is the same for all the teeth. $\times\frac{1}{2}$.

under the name Gigantopithecus blacki, "Gigantopithecus" referring to its gigantic dimensions, "blacki," in honor of Davidson Black. Two years later the second tooth was picked up, this time an upper molar, again without roots but less worn than in the first case (Fig. 56, *A*). About two years after that, the third tooth was discovered, again a third lower molar, but almost completely intact and with one of the roots preserved (Figs. 57; 58, *A*). I do not know whether all three teeth came from the same drawer and the same shop. In any case, they represent the same type and at least two, possibly even three, different adult individuals. Von Koenigswald did not seize the opportunity to complete his first diagnosis or to correct it on the basis of the evidence provided by the much better-preserved teeth. So I took up the question again, suspecting that there might be some

relation between these gigantic ape teeth from China and the giant human jaw from Java. My suspicion proved justified.

A thorough comparative study revealed that the teeth are those of a member of the undoubtedly most advanced primate group, as rightly stated by Von Koenigswald (1935). However, this primate was not a giant ape but a giant man and should, therefore, have been named Gigantanthropus and not Gigantopithecus. If the size of the crown is disregarded, the relative size of the individual cusps, their arrangement, and their special form agree with none of the anthropoids, either living or fossil, but with man; also, the teeth are more like those of Pithecanthropus, Sinanthropus, and modern man than those of other

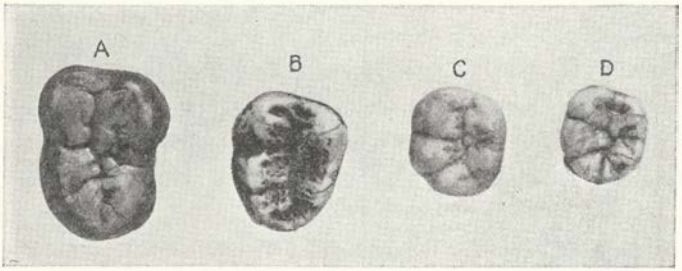

FIG. 58.—The same tooth as in Figure 57, in occlusal view. ×1/1

types (Figs. 56 and 58). The system of wrinkles which occupies the surface of the cusps is less complicated than in anthropoids and even less so than in Sinanthropus. But there are some details in both upper and lower molars which are of a very primitive character—certainly more primitive than in any human form known so far. The molars of Gigantopithecus are more than one-third larger than those of Meganthropus, the Java giant, and almost twice as large as those of the big Pithecanthropus. Figure 59, showing a scale plotted on millimeter paper, gives an idea of the differences in size. The figures on the left indicate the size of the rectangles of the two molars (length times breadth) in square millimeters. Neither the height of the crown nor the volume of the root is included in this calculation. Since both of the Gigantopithecus teeth are primitive to the same degree, it is obvious that size and primitiveness go hand in hand.

In other words, the giant from the Hong Kong chemist shop and the giant from central Java are in the same evolutionary line; the more primitive the forms are, the more gigantic are their dimensions.

When we speak of giants, everybody wants to know how tall they were, compared with modern man. This is an easily understandable but a very ticklish question, for there are no scales which permit us to read the stature of the body from the size of the teeth. Relatively small animals may have large teeth, and vice versa. But in most cases, and especially in Primates, large teeth necessitate large jaws, and large jaws a large body, as we know from fossil giant lemurs of Madagascar. As a matter of fact,

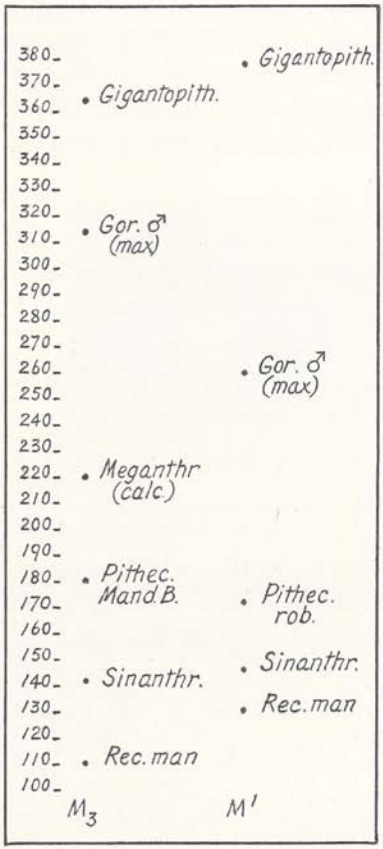

Fig. 59

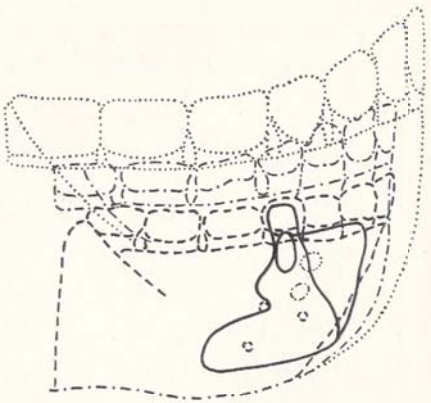

Fig. 60

Fig. 59.—Scale of the size of the teeth of Gigantopithecus expressed in square millimeters of the crown (length × breadth) and compared with the teeth of gorilla, Meganthropus, Pithecanthropus, Sinanthropus, and modern man.

Fig. 60.—Diagram showing the difference in size of three lower jaws from the Trinil horizon of Java and that of Gigantopithecus, the latter calculated from the size of the molar: Kedung Brubus (——); Pithecanthropus (.....); Meganthropus (- . - .); Gigantopithecus (. . . .). $\times\frac{1}{5}$.

the molars of the Chinese giant are, in volume (crown and root together), from five to six times larger than those of modern man. A fair idea of the probable size of the body of the lower jaw of Gigantopithecus can be conceived when a reconstruction is based on the size of teeth and bones of the other known Java fossils with which it is compared. In Figure 60 the contours of four fragments of these lower jaws have been superposed. The smallest piece (heavy continuous line) is the jaw of Kedung Brubus, discovered by Dubois in 1889 and attributed to Pithecanthropus erectus (1924); the next in size (broken line) is the Pithecanthropus lower jaw of 1937 (Fig. 47); then follows (broken and dotted line) the Meganthropus jaw (Figs. 51–54); and the largest (dotted line) is the reconstruction of the jaw of Gigantopithecus. The Kedung Brubus jaw and tooth are about the size of jaw and tooth of modern man. Therefore, it may not be too far from the truth if we suggest the Java giant was much bigger than any living gorilla and that the Chinese giant was correspondingly bigger than the Java giant—that is, one and a half times as large as the Java giant, and twice as large as a male gorilla.

The Java giant and the Chinese giant appear as a morphological continuation of the large Pithecanthropus—a continuation upward as regards size and downward as regards time, or, to be more correct, at least as regards primitiveness. The skull itself of the big Pithecanthropus, which I have called Pithecanthropus robustus, appears as the continuation of both Dubois's Pithecanthropus skull and its image, Von Koenigswald's Pithecanthropus skull, which are representatives of Pithecanthropus erectus. The giants and near-giant forms are thus connected with the normal-sized early types. The human line, especially the most primitive group, has been considerably extended by these new discoveries and by the more correct interpretation of Pithecanthropus robustus as a form intermediate between the normal-sized and the giants (cf. Fig. 30). I believe that all these forms have to be ranged in the human line and that the human line leads to giants, the farther back it is traced. In other words, the giants may be directly ancestral to man. This conclusion is based on the facts (1) that giantism is combined with massive-

ness, and the massiveness decreases in accordance with the size; and (2) that human fossil types with large dimensions and very massive bones may sometimes also occur in later stages. Among the Homo soloensis skulls of Java are some which combine both peculiarities; Skull V, for example, is the longest fossil human skull ever observed and is very massive (Fig. 39). The Rhodesian skull is another example of massiveness (Fig. 40). The Heidelberg jaw (Fig. 54, *B* and *D*) may also be referred to in this connection, although it is no challenge to the more primitive giants.

A question difficult to answer in the present stage of our knowledge is whether the human line led only to giants or whether there were also small forms among them, as is the case in man today. The two Pithecanthropus erectus skulls, first considered as females, are very small, indeed; and among the Sinanthropus skulls there is at least one with very small dimensions—distinctly smaller than the others. So it may be that the giants are only variations—whether local or more widely spread remains, as yet, undecided.

Calling the giants morphologically older than all other known human types presumes that the giants from Java and China are not only more primitive but also geologically older than Pithecanthropus. There are merely indications in this direction so far, no evidences. All the Java finds except Homo soloensis, which was recovered from a geologically younger level than Pithecanthropus, came from the same horizon, the so-called "Trinil beds." But this does not mean that all the types were contemporaneous, for all the bones came from secondary deposits. The geological structure of Java and the stratigraphic conditions prove that during the whole Pleistocene period there were repeated volcanic eruptions, accompanied by devastating torrents and mud streams, which swept down from the slopes of the volcanoes and scooped up large masses of soil, transporting them, with all their contents, to geologically different places (cf. De Terra, 1943). The map of central and East Java (Fig. 61) shows the localities from which the human fossils referred to in this discussion were taken. All were found north of a chain of high volcanoes (Merapi, Lawoe, and Willis) in an area extending from west to east. The whole area is drained by the Bengawan (Solo)

River and its tributaries. Dubois's Pithecanthropus calotte came from Trinil (bank of the Solo River); the new Pithecanthropus finds and Meganthropus from Sangiran (bank of the Tjemoro River); and Homo soloensis from Ngandang (terrace of the Solo River). Almost all the fossils are crushed and broken. Von Koenigswald had earlier (1936) reported a find which came from a horizon (Djetis) underlying that of Trinil and, therefore, considered to be geologically older. This find is also a skull; but, unfortunately, it is that of a baby hardly older than a year, if

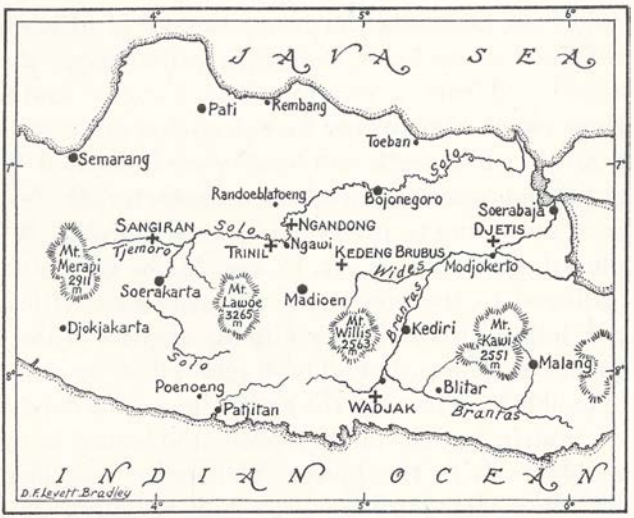

FIG. 61.—Map of central and East Java, showing the chain of volcanoes and the valley of the Bengawan (Solo) River, with the sites of the human finds marked by a cross.

that old. He called it Homo modjokertensis (see Fig. 61 [map]), and it undoubtedly represents an early human type. But which one, it is difficult to say, for no more than the brain case is preserved, and there is no other fossil material of the same individual size with which to compare it.

In view of the difficulties in the case of the new Java finds, it seems hopeless to say anything regarding the age of the giant Chinese teeth. The only definite thing we know concerning their provenance is that they were picked up out of a cabinet. This is certainly not a reliable geological horizon. But, strange as it

may sound, we are, nevertheless, as well acquainted with this provenance as with that of the Java finds—in some regards, even better acquainted. The Gigantopithecus teeth were not the only ones in the shop drawers, which were filled with other mammalian teeth and bones. The other teeth had in common with the Gigantopithecus teeth the fact that most were deprived of their roots; and there were signs that the teeth, as well as the bones, had been gnawed off by big rodents. The animal teeth recognized by Von Koenigswald and purchased with the Gigantopithecus teeth were those of Stegodon, the elephant of those times, and of the tapir and the orangutan, all of which lived in southern China, as we know from excavations made there. All had been gathered from caves south of the Yangtse; and the bottom of these caves was covered by a deep layer of a yellow-colored deposit, in which teeth and bones were imbedded. The colored matrix that was recognized as a characteristic feature of these caves, according to my geological collaborators in China, Père Teilhard, C. C. Young, W. C. Pei, M. N. Bien, and H. C. Chang, adhered to the bones and the exposed cavities of the teeth; and, indeed, it still partly fills the cavities of the Gigantopithecus teeth. The roots had been gnawed off by porcupines. It is not possible to determine the exact time of the deposition of the yellow matrix, but the fauna represented belong to the Middle, probably even to the Lower, Pleistocene and have been called the "Sino-Malayan fauna" by Von Koenigswald (1935), Père Teilhard, Colbert, and others, since exactly the same association of mammals has been found through southern China, Burma, Indo-China, and Java. As Java emerged from the sea in the late Tertiary, the already highly specialized fauna must have migrated to Java from the continent. The route taken is pointed out by the dispersion of the localities where the finds were made. It runs from southern China to Java, on one hand, and to northern China, on the other.

Colbert showed, furthermore, that the dispersion of the Sino-Malayan fauna points also in the direction of India. Figure 62 (map) shows the distribution of the Sino-Malayan fauna as is known by excavations made to date. The sites of the finds are indicated by numbers 2–8. The arrows mark the route and the

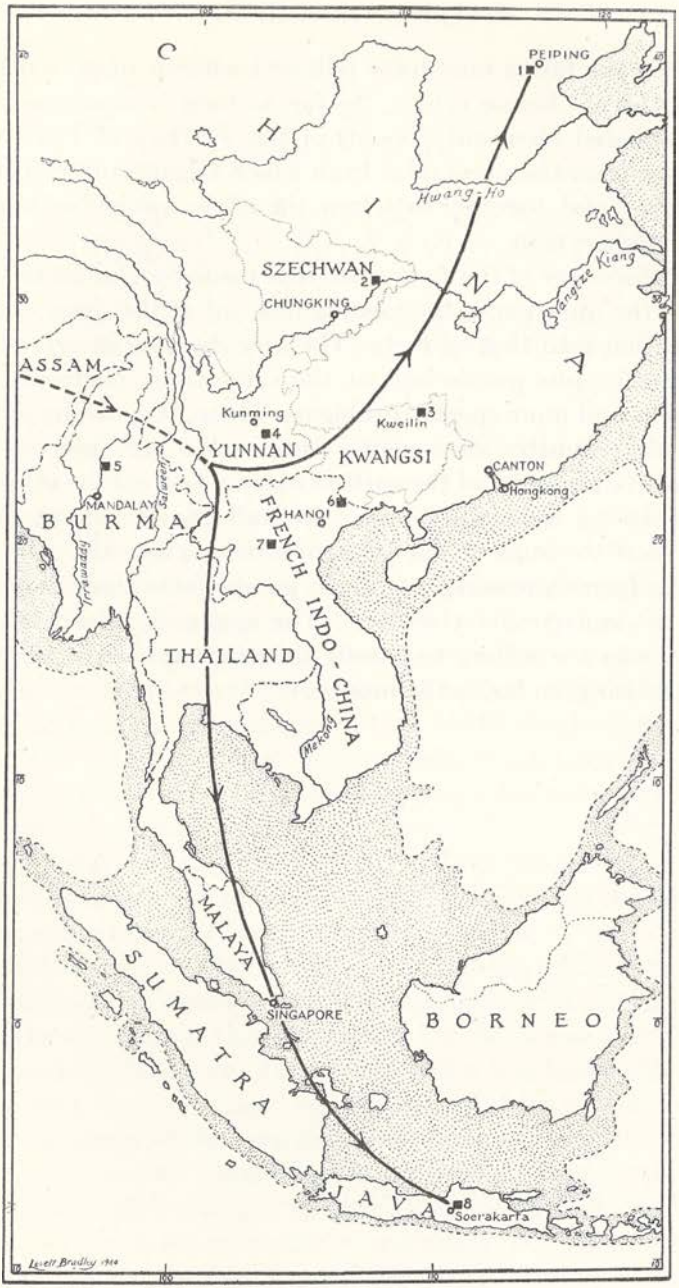

FIG. 62.—Map of southeastern Asia and Indonesia, showing the distribution and supposed dispersion of the Sino-Malayan fauna. The sites of finds are marked by black squares.

direction the fauna may have followed when it dispersed from its southern Chinese center. So far as man is concerned, the short-snouted fossil anthropoids of the Tertiary of India may easily be from the same stem from which Gigantopithecus took its origin—and, together with him, the whole special line leading up to modern man.

The discovery of the Java man, first made by Dubois in 1891, shifted the question of the missing link out of the stage of pure speculation into that of facts. The new discoveries solved the Pithecanthropus puzzle but, at the same time, confronted us with new and more specific problems. These, too, can be solved. The only requisites are a spade, a hoe, and a little money. The sites where the relics of the earliest human past can be exhumed —in Java, as well as in China—are well known, almost to the spot where the implements have to be driven into the soil. The chances for rich rewards are much greater here than they ever were in similar cases elsewhere. The spade, the hoe, and the people who are willing to handle them are available; the only thing missing, so far, is the money.

CHAPTER IV

THE HUMAN RACES: PRINCIPLES OF THEIR CLASSIFICATION AND ORIGIN

> Race is not a permanent entity, something static . . . . it is dynamic and is slowly developing and changing.
>
> —Roland B. Dixon

IT IS a fact that no two individuals are alike in their physical appearance. The differences which occur may be small or great, depending, above all, upon the special character and the number of the diverging peculiarities. In addition, the variability of mankind as a whole appears the greater, the greater the number of individuals taken into consideration and the greater the areas compared. The ancient Egyptians were already aware of the fact that great physical differences were discernible within the population of Egypt and within that of the neighboring countries. This is evidenced by the care with which they characterized these peoples in their sculptures and in the paintings on the walls of their temples.

But it was not until the beginning of the nineteenth century that an attempt was made to classify mankind on the basis of bodily similarities and dissimilarities according to the zoölogical rules introduced by Linnaeus. Yet the principle of dividing mankind into "races" goes back to Blumenbach, who distinguished five: the Caucasian, the Mongolian, the Ethiopian, the American, and the Malayan. This classification was based chiefly on differences of complexion; but the forms of hair, of nose, and of the face as a whole were also used to make the distinction as precise as possible. Blumenbach's definitions of these races and the number of characters which he considered decisive do not cover, of course, all eventualities and needs. For, since Blumenbach's time, the number of racial groups has increased from five to thirty-eight, usually arranged in three main races, twenty-nine subraces, and three intermediate and three special races,

as Von Eickstedt's latest tabulation (Table 1), characteristic of all classifications of this sort, shows.

Although Von Eickstedt claimed to maintain Blumenbach's main principle, namely, the color of the skin, he practically invalidated this system by ranking such dark-colored peoples as the Dravidians and Veddas of India with the leucoderms, or whites. This latter classification issues from a fundamentally wrong principle. The Dravidians have been ranged in the group of leucoderms because tradition relates that during early historic times people with fair complexion lived in the territory now occupied by the Dravidians. Therefore, the identification

TABLE 1

RACIAL CLASSIFICATION OF RECENT HOMINIDS

Groups	Europeoform Main Stem (Leucoderms, the White Race)	Negroform Main Stem (Melanoderms, the Black Race)	Mongoloform Main Stem (Xanthoderms, the Yellow Race)
Large racial units (*Rassenkreis*)	Europoids (including Indoids)	Negroids	Mongoloids
Parallel subraces	Polynesoids	Melanesoids	Amerindoids
Special groups	Veddoids	Pygmoids	Eskimoids
Intermediate groups	Ainuids	Australoids	Khoisanoids

of this ancient people with the entire modern Dravidian group indicates that it is considered allowable to take as leading criteria for the classification of present mankind not only its present physical status but also the status it may have had thousands of years ago. In the case in question, it has been completely ignored that the alleged white racial component of India merged into the dark components—in other words, that a great part of the Indian population has changed its racial character. On the other hand, classifications like those of Von Eickstedt do not provide for similar affinities between whites and blacks (melanoderms), between whites and yellows (xanthoderms), or between the blacks and yellows, although it may be assumed that the whites owe their present fair complexion to a process of depigmentation and that the present differences in skin and hair color certainly did not exist to equal extent in earlier times.

The definition of a "human race" and the criteria on which its distinctiveness is based are determined fairly arbitrarily by anthropological taxonomists and have been approved and sometimes even sanctified by open or tacit convention. A priori, every specialty of the body can be regarded as an indicator of genuine group differences provided it fulfils the following conditions: (1) it is transmissible to other individuals by heredity, (2) it is unalterable for a reasonably long period of time, (3) the range of its variability caused by external influences is small, and (4) it is relatively independent of sex and age. A race as such, however, is never determined by one of those characters alone but by a number of characters which are more or less correlated with each other. The fewer the number of characters selected as criteria, the fewer will be the number of distinguishable races but the greater the number of individuals attributable to a given race. On the other hand, the greater the number of critical characters, the greater the number of races and the fewer the individuals belonging to each. Human races, which may here be called "anthropological races" because they are the only ones so far acknowledged by anthropologists, are geographically determined groups, or so they are presumed to have been at one time. According to the present distribution of these races, the whites are cosmopolitans, and the blacks and yellows are on the way to becoming so. But all available facts indicate that in earlier times the whites settled only in Europe, western Asia, and northern Africa; the Negroes mainly in Africa; and the Mongolians in Asia. Similarly restricted settlements are supposed to have existed for the smaller subdivisions of the main groups, a great many of which seem to be confined to certain regions of the earth even today. Yet it is evident that the geographical distribution on which classification of modern mankind is based was not more stable in earlier times than it is today. On the other hand, it is obvious that essential racial differences could not have been developed and maintained unless the interchange of genes responsible for the differing features was controlled by certain measures.

However, not all of the possible differentiations which allow grouping of human beings have, or could have had, a strict geo-

graphical localization. Medical men first recognized that within a given population a certain percentage of individuals can be distinguished by hereditary peculiarities of their bodies—peculiarities which may, but do not necessarily, indicate a predisposition to certain diseases. Four of these so-called "constitutional" types have been described. There was considerable divergence among the earlier authors as to the main characteristics of these types; but an agreement seems to exist, at least for the two most contrasting ones, although they still go under different names. The French anthropologist Manouvrier spoke of "macroskèles" and "brachyskèles"; later French physicians, of "type respiratoire" and "type digestif"; and German authors, of "phthisic," "asthenic," or "leptosome" types, on one hand, and "pyknic" or "eurysome" ones, on the other (cf. Weidenreich, 1927). The American anatomist Bean called one type "hyperontomorph" and the other "meso-ontomorph." Stockard called one "lineal" and the other "lateral." Whatever the names, one type is characterized by a slender body build and a long and narrow face; the other, by a stout body build and a short and broad face. Some authors went beyond such a cursory characterization and gave more detailed physiognomical descriptions. According to Bean, for example, the nose of the hyperontomorph type is usually long, high, and narrow, with high bridge and high tip; the nose of the meso-ontomorph type, on the contrary, is large and relatively broad, with the bridge depressed. The trunk of the slender type is long and narrow, and so are the extremities; while the trunk and the extremities of the stout type are broad and short.

Bean stated that these "constitutional types" are not restricted to the whites but are also found everywhere among the African (1924) and yellow-brown (1925) races. I was able to show (1927) that they can be picked out of any population on the earth, no matter to which race this population may be attributed on the basis of its "anthropological" characteristics. The constitutional types, even of the most exotic races, conform to the European standard not only so far as the general build of their body is concerned but also in regard to detailed physiognomical traits—for example, traits of the nose—as these

traits have been defined by Bean. To illustrate this in only two cases of greatly differing races, Figures 63 and 64 show the slender and stout types of the Melanesians (*A*, front view; *B*, profile). Note the difference in the form of the nose: in the front view both noses are broad, but in profile that of the slender type is convex and that of the stout type concave (snub nose). Figure 65 illustrates the same two types among male and female Japa-

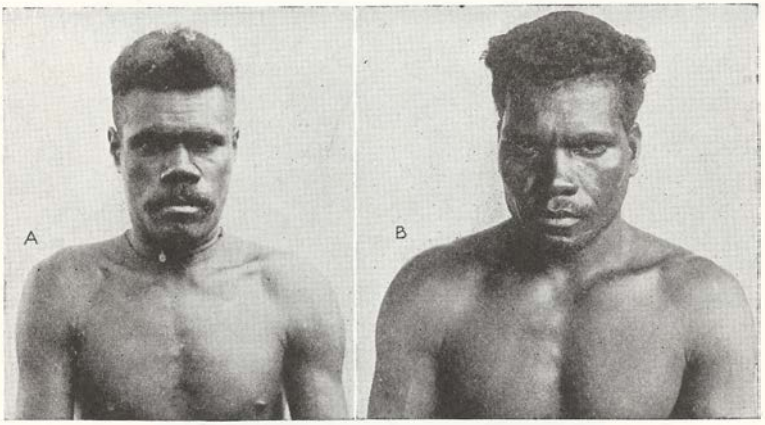

FIG. 63.—Melanesians of the slender and stout constitutional types. *A*, slender type; *B*, stout type. Front views. (Courtesy of the late Dr. F. Sarasin.)

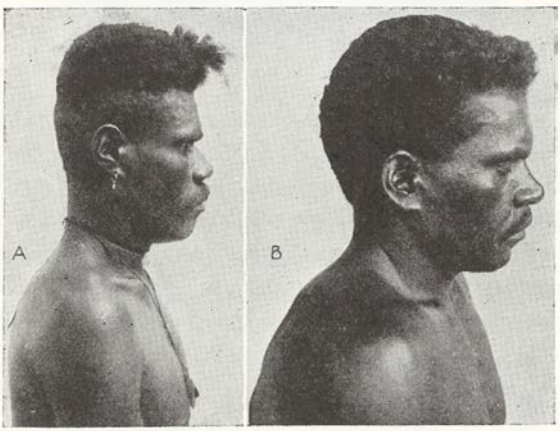

FIG. 64.—The same as in Figure 63. Lateral views

nese. These individuals were accidently seated side by side in a group picture taken in Tokyo. Here, also, the characteristic form differences of the nose are evident.

It is a fact, stressed by all students, that constitutional types are inheritable, although the special mode of their transmission is not clear. Some groups of Nilotic Negroes are excellent examples for demonstrating the constancy of the slender type within a given racial combination. Most individuals of the Watussi, Dinka, Shilluk, and Masai tribes of eastern Africa are very tall.

FIG. 65.—Japanese men and women of pronounced slender and stout constitutional types. (Photograph taken on occasion of a banquet in Tokyo, 1936.)

Their great height is combined with an extremely long and narrow face and brain case (Figs. 66 and 67). Exactly the same skull type (Fig. 68) has been found among skeletons excavated from a cemetery in Aniba, the ancient capital of Nubia, which flourished about the third millennium before Christ (see Weidenreich, 1934; Kretschmar). Moreover, the Oldoway skull of Kenya (Fig. 69) displays all the characteristics of the Aniba skulls and those of the recent Nilotic group. Although the exact geological age of the Oldoway specimen is debated, it is certainly

a fossil, perhaps representing an upper-paleolithic form. In any case, the skull demonstrates the antiquity and constancy of the slender constitutional type.

The constitutional types appear, therefore, as variants of common human forms, not less distinguishable than "racial" types which differ in skin, eye, or hair color; yet the latter had the privilege of having been selected earlier and of having attained official acknowledgment as "the" human races. The essential difference between the two kinds of types is the fact that

FIG. 66.—Sultan of the Watussi tribe of Uganda (eastern Africa). Slender constitutional type. (After Weiss.)

the constitutional types are not herded, as are the races, but usually represent sporadic, individual variations within an otherwise seemingly homogeneous population. All students agree that the number of individuals who conform to the requirements of the ideal constitutional type is relatively small; but the same holds true for racial types, as will be shown below. On the other hand, the number of a constitutional type may occasionally increase to such an extent that these individuals form a more or less distinct subgroup within a large population. The aforementioned Watussi are a good example of such an occurrence. They share this peculiarity with the pygmies; this hu-

man variant, too, is a typical constitutional type which can make its appearance within any taller population and nevertheless maintain its dwarfish condition. In neither case is complete geographical isolation required. The three individuals depicted in Figure 67 represent three different Negro types. The tallest is a Watussi (see Fig. 66); the smallest, a Mutua, a man who shows all the characteristics of a pygmy (note especially the dif-

FIG. 67.—A Watussi, a Wahutu, and a Mutua from Ruanda (eastern Africa), representing a tall, slender constitutional type; a small, stout constitutional type (pygmy); and a "normally" built Negro. (After W. Kuhnert.)

ferences in the form of face and nose between the Mutua and the Watussi). The medium-sized man is a member of the Wahutu tribe, which is racially classified as of the Bantu-Negro group. The three types live in Uganda (eastern Africa), side by side, without any sharp geographical separation.

The official classification of the human races did not take into consideration the occurrence of constitutional types. Their

morphology has not been acknowledged as a generally valid racial criterion, although single constitutional features, such as stature, body build, and physiognomic traits of the nose, have been admitted. But the latter concession has been restricted to the classification of the subgroups of the whites only. It was never extended to other races, although the frequent occurrence

FIG. 68. Skull of an extremely slender constitutional type. Nubian from an ancient cemetery in Aniba (valley of the Nile) about 2500 B.C. *A*, front view; *B*, lateral view.

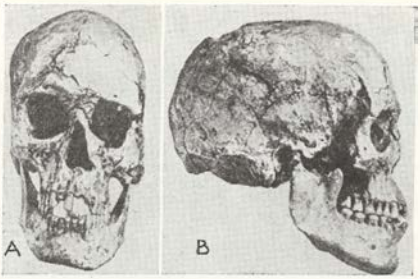

FIG. 69.—The Oldoway Skull of the province of Kenya (eastern Africa), Upper paleolithic (?). (After Theodor Mollison and W. Gieseler.) *A*, front view; *B*, lateral view.

of slender and stout forms—for instance, among the Japanese population—has not escaped the attention of anthropologists. But classification here has not gone beyond the designation of names, such as the "Choshiu type" for the slender form and the "Satsuma type" for the stout one (Fig. 65).

In dividing the whites into subgroups there were no scruples about referring to obviously constitutional peculiarities if the ordinary racial characters did not suffice to secure the desired

diagnosis. The Nordic race (Fig. 70), in its most perfect expression, is characterized not only by fair complexion but also by a tall and slender stature and a long narrow face. Even the degree of the allowed convexity of the nasal bridge is fixed by strict limitations. The Alpine race (Fig. 71), on the other hand, is characterized by, in addition to dark complexion, a small and stout stature, a short and broad face, and a snub nose. In many textbooks considerably more detailed instructions for determining the distinctions between these two races are given. The following "racial" characters of body build and nose form, such as,

FIG. 70.—Nordic racial type. (After E. Fischer and H. F. Günther.)

for example, those emphasized in Hooton's book, are undoubtedly "constitutional" characteristics.

Body build of the Nordic race.—Tall, slender; long neck; sloping shoulders of medium breadth; flat, shallow chest; long legs.

Body build of the Alpine race.—Thickset; short, thick neck; broad shoulders; deep chest; short, thick extremities.

Nose form of the Nordic race.—Long, high, narrow; straight or, less frequently, acquiline; thin tip; not usually depressed.

Nose form of the Alpine race.—Usually fleshy ("blobby"); short tip.

If an individual combines the body build of a Nordic with a dark complexion, or the body build of an Alpine with a fair complexion, he may be assigned to the Mediterranean or the eastern Baltic race, respectively. Nasal geometry, elaborated too artfully, can occasionally lead to situations very embarrassing for racial theories, as a comparison of the profiles of the death mask of the "Nordic" Prussian king, Frederick the Great, and the mummy of the "Hamitic" Egyptian Pharaoh, Rameses the Great, demonstrates (Fig. 72).

However, leaving aside such exaggerations of the principle of classification, there is no reason why constitutional peculiarities could not be used for the characterization of anthropological races, provided they are applied to all eventualities and the grouping is not confined to strictly geographical differences. The

FIG. 71.—Alpine racial type. Woman from the Swiss canton Grisons

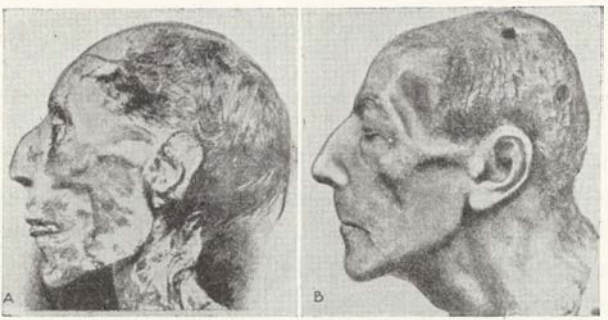

FIG. 72.—Head of the mummy of the Egyptian Pharaoh, Rameses the Great (*A*), and death mask of the Prussian King Frederick the Great (*B*).

only effect of such an extension is, of course, a further increase in the number of the races and a corresponding decrease in the number of the individuals that conform to the demands of each division of a still more specific racial scheme.

An additional complication of the racial problem has been provoked by serologists, who have discredited the usual anthro-

pological classification of mankind because the anthropologists disregard the new "physiological method" for classification offered by the serologists. The blood, the cells, the tissues, and all body fluids contain chemical agents which produce characteristic reactions when brought in contact with the blood of other individuals. Four different groups of individuals, designated with the letters "O," "A," "B," and "AB," are distinguishable. The group blood quality is unchangeable during the lifetime of an individual and is transmissible to the descendants according to Mendel's laws. Every individual in the whole world can be as-

TABLE 2

FREQUENCIES OF THE BLOOD GROUPS: O, A, B, AND AB

Populations	O	A	B	AB
Eskimos	80.7	12.9	2.4	4.0
Argentines	59.0	28.0	18.0	2.0
Bantu Negroes	53.2	18.6	24.5	3.6
Giliaks	50.0	27.4	14.5	8.0
Germans (Eifel)	46.5	44.8	5.2	3.5
Germans (Baden)	38.1	48.1	10.9	2.9
Dravidians	24.3	27.5	36.8	11.4
Egyptians	24.0	32.0	30.0	14.0
Koreans	17.9	36.6	33.7	12.5
North American Indians	91.3	7.7	1.0	0.0
Australians	55.0	38.0	5.9	1.1
Negroes (Congo)	45.6	22.2	24.2	8.0
Swedes	43.0	42.0	8.0	7.0
Ainu	11.6	29.3	34.1	25.0

signed to one of these four blood groups. Indeed, these groups have been checked in all main races and all subdivisions, and their frequency is known for thousands of individuals and for almost all peoples in the world (Table 2). In the Eskimo or North American Indians the overwhelming majority of individuals belongs to the O group. Among the Argentines, Bantu Negroes, Australian aborigines, Germans from the Eifel, and the Mongolian Giliaks of Sakhalin, the O individuals are in predominance and show about the same frequency in each group. In Koreans, Australians, and Egyptians the percentage of A individuals is the same, but not that of the B individuals, who are, however, equally frequent in Dravidians, Koreans, Egyptians, and the Ainus of Japan.

Unquestionably, mankind can be classified serologically according to the frequency of the blood qualities; but these serological groups are not identical with those obtained by the customary anthropological methods, nor is there any correlation between them. This is frankly admitted by the seroanthropologists themselves. They have stated again and again that there is no mutual relation between anthropological, constitutional, and serological types; nor are there any other characteristics which unite individuals of the same blood quality. One of the first results obtained by the serologists who tried to find such a relationship is shown in Table 3. The figures reveal that the frequency of each of the four blood groups can be the same,

TABLE 3*

RELATION BETWEEN BLOOD QUALITY AND HAIR COLOR, TESTED ON 1,152 INDIVIDUALS
(In Percentage)

Hair Color	A	B	AB	O
Blond	44.2	8.6	2.3	44.9
Brown	42.0	9.6	3.0	45.4
Black	44.5	7.8	3.6	44.1

* After L. and H. Hirschfeld.

regardless of whether the tested individuals have blond, brown, or black hair.

Since there is no correlation between racial characters (such as have been used by the anthropologists) and blood qualities, and, in addition, since an anthropological race is not determinable by one such character alone, the anthropologists were right in neglecting the serological criteria. All the more so since their system is based on the principle of the geographical restriction of the racial characters. However, the distribution of the blood qualities, as it is today and as it is supposed to have been in the past, gives no convincing evidence of a strictly geographical distribution, despite all claims of the serologists to the contrary. Charts have been constructed by the serologists to show the routes along which blood qualities have spread over the globe. Of course, blood qualities must have traveled, for man, their bearer, has traveled; but in which special race-disguises the

qualities were concealed, it is impossible to determine, simply because there is no strict correlation between race and blood group, as stressed by the serologists themselves. Boyd, who is fully aware of these difficulties, confines the real anthropological worth of the blood qualities to their fitness as a guide through the maze of racial history, particularly in regard to early mankind. But even with this reservation, morphological features, as they have been preserved in the skeleton, are certainly more elucidative for this purpose.

It has been shown that the apes—particularly the anthropoids—possess, in principle, the same blood groups as man. This being so, the quality of the blood must be of very ancient character and, therefore, a very old heritage. The distribution through mankind may have occurred long before the morphological characters chosen for the anthropological classification of today were developed.

Should, however, anthropologists yield to the demands of the seroanthropologists and accept the blood qualities as essential criteria for the classification of modern mankind, there is no other way of incorporating them in the anthropological system than to subdivide each of the acknowledged racial groups according to the special blood qualities recognizable in them. But, if this were done, a new difficulty would arise. In late years, additional blood qualities have been discovered. The group A itself has been subdivided into four subgroups; and new groups have been added to the already existing list, namely, the groups M_1 and M_2, N_1 and N_2, and Rh, etc. Not less than 2,560 kinds of human blood are now serologically distinguishable. It is not known, so far, whether and in what frequency all these groups are distributed over the populations of the earth. Should all of them occur in all thirty-eight anthropologically distinct races and subraces, we would have 92,780 different racial groups—not including the "constitutional" types and their combination with the "anthropological" and serological ones. The main qualities of all these groups would agree with the demands of geneticists and serologists.

It is difficult to see what would be gained by carrying the racial classification of mankind to its final possibilities. But, even

if this were done, the majority of each population would consist of intermediate or indefinite groups and individuals defying any exact classification. In no case could their characters be fitted into any approved scheme. Schlaginhaufen, the Swiss anthropologist, calculated the number of combinations in which four acknowledged racial characters can be found in a given population. The control group consisted of two hundred and fifty Swiss draftees from three German-speaking cantons. Although Schlaginhaufen selected only four characters and was very liberal in allowing for their range—stature: small, medium, and tall; head index: dolichocephalic, mesocephalic, and brachycephalic; eye color: light, intermediate, and brown; hair color: blond, brown, black, and red—he found not less than forty combinations. The combination considered as typical for the (1) Nordic race—namely, tall, dolichocephalic, light eyes, and blond hair—was found in no case; that typical for the (2) Alpine race—namely, medium height, brachycephalic, brown eyes, and brown hair—in 9.2 per cent of the group; that typical for the (3) Mediterranean race—namely, medium height, dolichocephalic, brown eyes, and brown hair—in 0.4 per cent; and that typical for the Dinaric race—namely, tall, brachycephalic, brown eyes, and brown or black hair, in 0.8 per cent. In other words, among two hundred and fifty individuals, only twenty-six, or 9.6 per cent, were racially "pure"; the remainder, namely, two hundred and twenty-four, or 90.4 per cent, were more or less mixed, or "hybrids." This, despite the complete neglect of all finer nuances in eye and hair color, which were emphasized as decisive criteria in each utterance of the racialists and faithfully accepted as such all over the world by scientists and laymen.

The interpretation of individuals presenting combinations other than the conventional ones as "hybrids" is based on the presumption that the features considered as characteristic of a race of today were much more pronounced in the past. In other words, it is taken for granted that all races were once "purer" than they are today and that their character has changed only by interbreeding. Interbreeding, however, is regarded by the racialists as an undesirable deterioration of the race, leading to a growing "impurity" of the "original" race.

So the problem of the origin of races arises. It is evident from the beginning that any search for stable archetypes, whether of Negroes, Mongolians, or any of the white racial groups, will be condemned to failure. All available facts indicate that crossing is not a late human acquisition which took place only when man had reached his modern phase but must have been practiced ever since man began to evolve (see chap. i). An inveterated, but erroneous, doctrine has tried to make us believe that Neanderthal man, or paleoanthropine man, was completely uniform wherever he may have appeared and that all the racial groups and subgroups of today are later differentiations of his descendants, likewise considered uniform at their first appearance. These ideas are the logical consequence of the basically wrong conception that man, as such, took his origin from only *one* center somewhere in the Old World, where he passed through all his former evolutionary phases. Only when the last phase (modern men) was reached did he migrate to other habitable regions in the periphery, where he was subjected to the modeling influences of environment and selection, which developed the racial differentiations as they appear today.

At the time these views were advanced, little was known of early man and his dwelling places. Human fossils had been gathered from Europe only; and those from outside Europe, like the Java man, were questioned and not generally acknowledged as being human. Under these circumstances the way was wide open for speculation. The epoch-making discoveries of the last twenty-five years brought all these unsubstantiated claims to a total collapse. Fossil human remains came to light from Asia and Africa, as well as from Europe. The Mount Carmel population of Palestine (McCown and Keith) and the recently discovered skeleton of an upper-paleolithic child of Uzbekistan in central Asia (cf. Weidenreich, 1945*a*) represent forms intermediate between the classic Neanderthalians of Europe and modern man (see chap. ii and Figs. 41 and 42). The Peking man (Figs. 9, *B*, and 28) and the new types from Java (Figs. 27, 49, and 50), related to Pithecanthropus erectus, have to be considered as evolutionary phases morphologically more ancient than all the others, while Homo soloensis from central Java (Fig. 39) closes

the gap between the older and the younger phases of fossil man (cf. Fig. 30). The designation of all these non-European specimens as "Neanderthal man" led to the conception that they were morphologically identical with the European form. However, a more thorough analysis, especially of the nonmetrical features, revealed that the conformity concerns only the general evolutionary status. Yet there are characteristic differences in details, which are equivalent to those which we consider as racial differences when they are found in modern man. Although Sinanthropus and Pithecanthropus agree, so far as their general character is concerned, they differ markedly in certain minor structures. Sinanthropus has a bump in the center of his forehead (Figs. 9, *B*, and 28), whereas the forehead of Pithecanthropus (Fig. 27) is flat; Sinanthropus has a narrow and elongated occiput, while that of Pithecanthropus is broad and rounded. Sinanthropus has small and contracted frontal sinuses; those of Pithecanthropus are very large and laterally extended.

Therefore, human forms preceding those of modern man were distributed over the entire Old World and differed typically from each other, just as is true of any present geographical variation. In addition, the ancient Javanese forms, Pithecanthropus and Homo soloensis, agree in typical but minor details with certain fossil and recent Australian types of today so perfectly that they give evidence of a continuous line of evolution leading from the mysterious Java forms to the modern Australian bushman (Fig. 73). The same holds good for the African branch. Rhodesian man (Fig. 40) can be linked with living southern African racial groups through the intermediate stages of the Florisbad man and the Boskop man, both recovered from southern African soil (Galloway). So far, no such link between the European Neanderthalian and the European form of modern man has been found in European soil. But the finds of Palestine (Fig. 41) and Uzbekistan prove that we have to look for those connections in western and central Asia.

Considering all this evidence, it seems that there must have been, not one, but several, centers where man has developed. But we should be completely at a loss if someone should ask on which special spot of the earth the decisive step was made that

led from a simian creature to man. There was not just *one* evolutionary step. Evolution went on wherever man may have lived, and each place may have been a center of both general development and special racial strains.

The particular question arises as to whether and to what extent the races of today are traceable to races of earlier phases of man's development. The fact that typical features of Australian aborigines occurred in Pithecanthropus and Homo soloensis (cf. the form of the forehead and supraorbitals in Pithecanthropus, Fig. 27; Homo soloensis, Fig. 39; and native Australians, Fig. 73, *A*, skull, and *B*, head) and have been maintained, despite the whole evolutionary progress made in the meantime, proves the possibility of their linkage. Sinanthropus furnishes a second example. One of its most striking features is a strange bony outgrowth at the inside of the lower jaw (Fig. 74, *A*). This is found in 50 per cent of the available Sinanthropus jaws but in none of the Pithecanthropus jaws or the European Neanderthal specimens. In modern mankind the same structure can be found in exactly the same place and the same degree of development (Fig. 74, *B*); but its occurrence is restricted to certain racial groups, and its frequency varies. While it is present to a high degree in neolithic Japanese and Chinese and reaches almost 90 per cent in Lapps and Eskimos, it is absent in Melanesians and negligible in whites. Furthermore, the upper incisors of Sinanthropus, particularly the lateral ones, are "shovel-shaped," as Hrdlicka has called this tooth form. Almost all Mongolians of today possess the same incisor type (Fig. 75). From these and some additional coincidences (cf. Weidenreich, 1943) it can be deduced that at least certain groups among the Mongoloid population of the earth must have taken over those specialties from Sinanthropus by inheritance, while the same peculiarities were transmitted to other races in a much smaller percentage or not at all.

If we want to find out how far back the characters of *living* races are traceable, we meet with the difficulty that the most striking features are those of skin and hair, while we are entirely dependent on skeletal parts for the identification of past races, especially fossil ones. Bone structures are much less definite and

are more difficult to define than the soft parts of the body. Another complicating factor is the tendency of man to interbreed without any regard to existing racial differences. This is so today; it has been so in historic times; and there is no reason to believe that man was more exclusive in this respect in still earlier times. The chance to meet "pure" races—provided they should be recognizable—diminishes correspondingly. Man has changed

FIG. 73

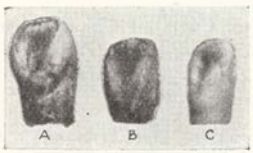

FIG. 75

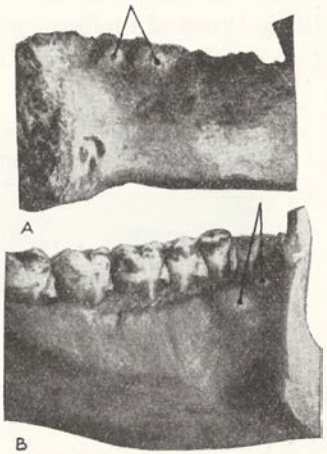

FIG. 74

FIG. 73.—Skull of an Australian aborigine (*A*)—No. 792, Coll. Sydney (Burkitt and Hunter)—compared with the head of a living one. (After Spencer and Gillen.)

FIG. 74.—"Torus mandibularis." Outgrowths on the inside of the lower jaw behind the canine and first premolar. Sinanthropus pekinensis (*A*); modern Chinese (*B*). $\times\frac{2}{3}$.

FIG. 75.—Upper lateral incisors (right side). Sinanthropus pekinensis (*A*); recent Chinese child (*B*); modern European adult (*C*). $\times 1/1$.

not only his general but also his racial characters continuously, as a consequence partly of a continuous acquisition of new properties and partly of crossing.

If this was so, how could distinct races ever have developed and persisted? If the cause of variability as a general biological problem is left aside, the usual answer to this question is that

the human groups have been kept isolated by insurmountable geographical barriers after they acquired their special qualities. But nobody has ever tried to check this theory against controlled or inferred facts, so far as human beings are concerned.

The development and stability of constitutional and serological types and their occurrence in all racial groups of mankind today, regardless of their special character, give evidence that geographical isolation is not and cannot have been a prerequisite for the establishment of speciations in man. What we know of the localization and distribution of the different upper-paleolithic types of modern man lends little support to the theory of separation and geographical isolation. From the so-called

FIG. 76.—Upper paleolithic man from the "Upper Cave" of Choukoutien. "Old Man"—Protomongoloid type (*A*); young woman—Melanesoid type (*B*); older woman —Eskimoid type (*C*).

"Upper Cave" of Choukoutien, situated at the top of the hill which yielded the remains of Sinanthropus, three well-preserved skulls, several fragments of some more, and skeletal bones of about ten individuals, altogether, have been recovered (Weidenreich, 1939). Their evolutionary phase corresponds to the fossil neoanthropine type (cf. Fig. 30). The condition in which the skeletons were found indicates that these individuals were members of one family, which was slain by an unknown assailant. The three skulls represent an old male, a middle-aged woman, and a younger woman, each one representing a different type (Fig. 76). The brain case of the old man (*A*) exhibits some Neanderthalian traits, while the face shows those which might be expected from a Mongolian prototype; the skull of the young woman (*B*) looks like that of a Melanesian of today; and the

skull of the middle-aged woman like that of an Eskimo (*C*). The surprising fact is not the occurrence of paleolithic types of modern man which resemble racial types of today but their assemblage in one place and even in a single family, considering that these types are found today settled in far remote regions.

Forms similar to that of the "Old Man," as he has been named, have been found in the upper paleolithic of western Europe and northern Africa; those closely resembling the Melanesian type, in the neolithic of Indo-China, among the ancient

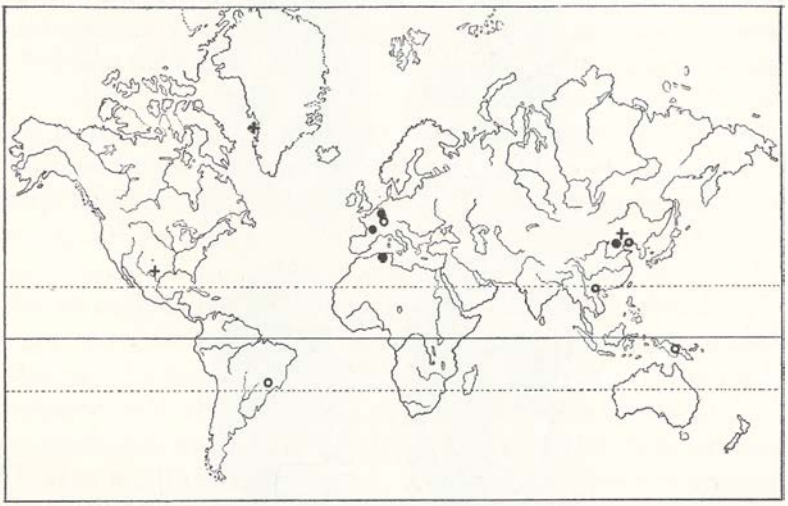

FIG. 77.—Map showing the distribution of types similar to those found in the "Upper Cave" (Fig. 76). "Old Man" type (●); Melanesoid type (○); Eskimoid type (+).

skulls from the cave of Lagoa Santa in Brazil, and in the Melanesian population of today; those closely resembling the Eskimo type occur among the pre-Columbian Amerindians of Mexico and other places in North America and among the Eskimos of western Greenland of today (cf. Fig. 77 [map]). Even if this should be interpreted as only proving early migrations and early interbreeding, it would demonstrate the eternal futility of human isolation. In any case, the existence of racial types in the past identifiable with those of today would demonstrate that their differentiation and fixation must have taken place long before upper-paleolithic time.

The upper-paleolithic melting-pot of Choukoutien does not stand alone. In Obercassel, in the valley of the Rhine, two skeletons—one of an old male and one of a younger female (Fig. 78, *C* and *D*)—have been taken out of one tomb which belongs to the Magdalenian period—the same period as that of the burial place in Choukoutien. The skulls are so different in appearance that one would not hesitate to assign them to two races if they came from separated localities. Before the idea of a unique up-

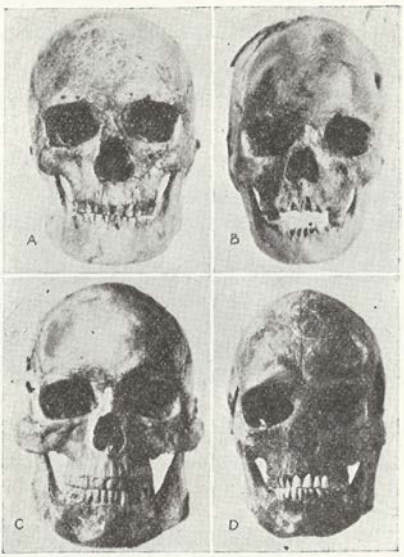

FIG. 78.—The paleolithic couple of the "Upper Cave" of Choukoutien (see Fig. 76, *A* and *B*), male (*A*); female (*B*). The paleolithic couple of Obercassel (valley of the Rhine), male (*C*); female (*D*).

per-paleolithic European race was promulgated by Morant, the Cro-Magnon man of southern France was considered the archetype of the European population; the man of Chancelade, discovered only a few miles from the site of the Cro-Magnon, was described as an Eskimo; and the Grimaldi couple from the French Riviera, buried in one tomb, like the couple of Obercassel, as Negroid. Even if these assignments should be too definite, the fact remains that the paleolithic population of western France already showed a considerable variety of types. Of no less importance is the fact that these types lived close together

in a relatively small area and that there are no signs of a strict separation by geographical barriers. All the facts available indicate that racial characters made their appearance as individual variations, like the constitutional and serological ones, and, furthermore, that they started with a great range of variations in a relatively small population. The kind of isolation mechanism which prevented the breakdown of the gene system remains to be studied. It cannot differ much from that which causes the persistence and stability of the nongeographical differentiations of modern mankind. However, this is a problem, not for physical anthropologists alone, but also for geneticists and sociologists.

Physical anthropologists have gotten into a blind alley so far as the definition and the range of individual human races and their history are concerned. Apart from the manifold difficulties presented by the purely physical aspect of the problem, the confusion has been increased by the persistent attempts to endow even quite insufficiently defined subraces with very definite mental qualities and to weigh the value of one group against the other on such an uncertain basis. In addition, it has been shown, above, that the number of individuals who conform to established racial schemes in all proclaimed characteristics is minimal, compared with those who do not, because they do not fit into any scheme or must be disregarded on account of their obvious hybrid or multihybrid characters. All this, together with the impossibility of separating sharply the variant human groups by the usual anthropological methods, induced some anthropologists to deny the real existence of human races entirely—at least in the same sense as races have been described in other species of the animal kingdom. Such an attitude throws away the good with the bad. One cannot push aside a whole problem because the methods applied and accepted as historically sacred have gone awry or because the results allegedly obtained have been misused by someone for nonscientific aims.

In any case, the following seems to be evident: Before any attempt can be made to ascribe mental qualities as inherent in any race by nature and not as resulting from tradition and education, the race to which those qualities are attributed should have been refined from all alien "impurities." Almost every psycho-

logical analysis of racial groups offered so far has not been based on studies of single individuals whose racial "purity" has been checked but has been obtained by deductions from the cultural and political history of the nations. However, it can be taken as a fact that no human group which ever made its appearance as a cultural and political unit was composed of only one racial element, either in the past or today. This holds good in particular for those human groups which played decisive roles in the history of mankind. Even leading German racialists, who were convinced of a close inherent correlation between physical and mental qualities and considered, in agreement with Count Gobineau, the Nordic race as the only creator of the great cultures of the earth, conceded that these cultures are the product of hybrids rather than of pure breeds. Ernst Kretschmer, the well-known psychiatrist and psychologist, arrived at the following conclusions in regard to the shares that the Nordic and Alpine races have taken in Western culture and civilization: "High cultures in their most marked form have so far developed within the sphere of the Nordic race only in those regions where that race has been exposed to an intense mixture with other races..... On the other hand, it is likewise certain that regions inhabited by the purest Nordic breeds . . . . are relatively poor in genius and cultural productivity. The most advanced European cultures never had their spiritual centers in Scandinavia, or in the northern coasts of Germany, or in Scotland, but always in zones where racial mixture took place."[1]

As the matter stands now, the only thing that can be done about the definition of races is to restrict the generally acknowledged racial characters to those groups which fulfil the four conditions stipulated at the outset of this lecture and to trace these features through the whole of mankind without regard to any previous racial definition or classification. Then the frequency of each combination and its geographical distribution should be noted and a framework built for the final subgrouping of the populations of the earth. This method is in agreement with the views of leading geneticists, like Dobzhansky, who says: "Although the genetic basis of relatively few human traits is known,

[1] *Geniale Menschen* (Berlin, 1929).

it seems that following up the distribution of these few traits could tell us more about the 'races' than a great abundance of measurements." By tracing back the really characteristic features to fossil forms where they first become recognizable, we will finally gather more knowledge of the history of, and relationship between, the races of today than can ever be inferred from vague descriptions handed down in folk tales and sagas, which refer, at best, to single individuals or special groups of the population and furnish, therefore, only a quite incomplete picture of the various constituents of a population and their percentages in it.

If the overwhelming majority of present mankind consists of "hybrids," for the reason that very few individuals correspond to the demands of a detailed racial scheme regarded as indispensable, one may ask: Where are the "pure" individuals who produce the hybrids anew each day? Every dog show exhibits "pure" breeds of the Doberman pinscher and makes us acquainted, at the same time, with the "impurities" of this breed. Although the Doberman itself produces marked mongrels when crossed with other races, the history of its race tells us that it was first bred, in 1865, by crossing Manchester terriers, Great Danes, sheep dogs, and setters. Nevertheless, today the notoriously hybrid Doberman pinscher is generally acknowledged as a "pure" race. What, then, makes the difference between hybrids and "pure" types, regardless of whether we are dealing with dogs or human beings?

CHAPTER V

FORM AND QUALITIES OF THE HUMAN BRAIN AND SKULL IN THE LIGHT OF EVOLUTION

> . . . . the size of the brain has become stable, its evolutionary path has turned a corner, and internal organization rather than bulk appears now to be of possible selective value.
>
> —GERHARDT VON BONIN

IN RETROSPECT, the trend of the evolution of man and the special differentiation of his body seems to have aimed, above all, at the enlargement of the brain. The human brain is considerably heavier and larger than that of any primate, particularly that of any anthropoid. But it is not the largest brain in the animal kingdom. The brain of an elephant is more than four times heavier and correspondingly larger than that of man, while that of a whale is almost ten times larger. However, if, instead of the absolute weight of the brain, its weight in proportion to the weight of the body is taken into account, the figures are quite different. In man 1 gm. of brain correlates with about 46 gm. of body, but in the elephant the correlation is 560 gm. of body and in the whale 8,300 gm. of body. Yet, in spite of this relative size of the human brain, man is not the brainiest creature. He is surpassed by the capuchin monkey of South America, which has 1 gm. of brain for each 17.5 gm. of body. These few examples are sufficient to show that neither the absolute nor the relative size of the brain allows cogent conclusions on mental superiority. This is a well-known fact as far as man himself is concerned.

The capacity of the skull of modern man varies from 910 cc. to 2,100 cc., if exceptional cases with lower or higher values or obviously pathological cases are neglected. The normal range is valid for all races of mankind, although there are some races with a relatively small average capacity and others with a rela-

tively great one. If dwarfish races are disregarded, the Australian aborigines, males and females together, have an average capacity of about 1,250 cc., as compared with 1,480 cc. for Eskimos. It was always tempting to use these differences in brain size, when they occur in whole racial groups, as indicators of physical and mental superiority or inferiority; the lower degrees, especially, were taken as a sign of physical and mental primitiveness. But when the brain sizes of the different evolutionary phases of man are compared with each other, it becomes evident that we are still far from understanding what these differences in size really mean and whether the most suggestive interpretation of an increase in size as tantamount to an augmentation of reasoning power and cultural progress is correct.

The three skulls of Pithecanthropus which are in a condition to allow a fairly precise estimate of the brain size prove that in this evolutionary phase the cranial capacity was no greater than a little over 900 cc. That of the best preserved of the three skulls measured only 775 cc. As the condition of this skull shows, this is a normal adult individual of advanced age. A cranial capacity of 775 cc. in adult modern man can be found only in an idiot with an obvious underdevelopment of skull and brain. Compared with the brain size of a normal adult human being of today, 775 cc. means that the brain of adult Pithecanthropus was not larger than that of an infant of about eleven or twelve months of age. On the other hand, compared with the brain size of anthropoids, it means that it had double the size of the brain of an adult chimpanzee and was only one-quarter larger than the largest brain ever observed in an anthropoid. Figure 79 shows casts of the cranial cavities of a gorilla (*A*), with a capacity of 600 cc.; that of Pithecanthropus erectus (*B*) (Skull II), with a capacity of 775 cc.; that of a Neanderthal man (La Chapelle-aux-Saints) (*C*), with a capacity of 1,625 cc.; and that of a modern European (*D*), with a capacity of 1,320 cc. Sinanthropus had a cranial capacity ranging from 915 cc. to 1,225 cc., with an average of about 1,040 cc. This is a considerably greater capacity than that of Pithecanthropus. Although it actually falls into the range of modern man, it remains close to the lower limit of the latter.

The picture changes when we go a step farther and scrutinize the cranial capacity of the Neanderthal man. In this type the capacity ranges from 1,200 cc. to over 1,600 cc. This is certainly a much greater capacity than that of Pithecanthropus or Sinanthropus .The amplitude of the range of modern man, varying from 900 cc. to 2,000 cc., is obviously still greater. But any comparison has to take into consideration that very few Neanderthal skulls are available; therefore, it may well be that they do not represent a fair average for comparison. If an average is calculated on the basis of the number of Neanderthal specimens available and of the range of modern man just mentioned, Neanderthal man has a cranial capacity of 1,400 cc. and modern man one of 1,500 cc. However, an average of 1,500 cc. for modern man is a much higher figure than that which has

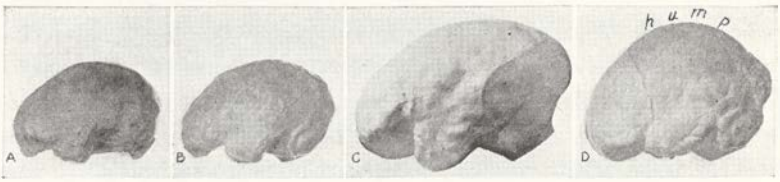

FIG. 79.—Endocranial casts of gorilla—*ca.* 600 cc. (*A*); Pithecanthropus erectus (Skull II)—775 cc. (*B*); La Chapelle-aux-Saints—*ca.* 1,620 cc. (*C*); modern man—*ca.* 1,320 cc. (*D*).

usually been computed. This figure is a little over 1,200 cc. for females and 1,300 cc. for males when all races are included. If these figures are accepted as the more nearly correct ones, Neanderthal man would have a greater capacity than modern man. In other words, the human brain case attained its greatest evolutionary expansion during the Neanderthal phase and has undergone a distinct diminution since. Such a statement seems, at first glance, surprising and completely unexpected. But several years ago (1934) Von Bonin arrived at the same conclusion. He said: "While the human brain is larger than that of our subhuman ancestors, no further increase has taken place since the time of Neanderthal Man, and there is a definite indication of a decrease at least in Europe within the last 10,000 or 20,000 years."

This brings an old question under discussion again. Eighty

years ago Broca, the French anthropologist, claimed that the cranial capacity of the Parisian population had increased since the twelfth century. In this case the alleged increase is minimal, rising from 1,425 cc. to 1,460 cc. Gustav Retzius (1915), testing Broca's results on Swedish skulls of neolithic and medieval times, denied Broca's conclusions. He was unable to confirm any increase in the cranial capacity during historic times.

General conclusions obtained on such scanty material are to be received with reservation. Nevertheless, it is safe to say that further expansion of the human brain case beyond the one reached in the Neanderthal phase about 100,000 years ago cannot be demonstrated.

In order to understand this paradox, one should remember that the transformation of the human skull consists not only in an expansion of the brain case and an enlargement of the brain but also in a very characteristic alteration of the form of the brain case, as set forth in chapter ii. The ideal form of that of early man looks like a loaf of bread. The ideal form of that of modern man, however, approaches a globular shape (cf. Fig. 9, *B* and *C*, and Fig. 34). Its base is deflected, and the occipital portion has bent downward. The body of the brain itself has become inflated, the greatest length and the greatest breadth having shifted from the base upward, the greatest breadth shifting high up toward the top (Fig. 35). All this is paralleled by a considerable increase in height. As the cast of the cranial cavity shows, the transformation of the brain has gone hand in hand with that of the brain case in which it is inclosed (cf. Fig. 79, *B* and *D*). Although the size of the brain of Neanderthal man is within the range of that of modern man, or even exceeds it, the form of his brain case, and therefore also that of his brain, is not more globular than that of modern man but distinctly less so. In other words, the height of the Neanderthalian brain is, in all cases, clearly inferior to that of modern man. This difference in the form of the brain of Neanderthal man and that of modern man is easily seen in Figure 79. Although the endocast of the skull of La Chapelle-aux-Saints (*C*) is larger than that of the modern man shown (*D*)—the capacity of the first is 1,625 cc. but of the latter only 1,320 cc.—the endocast of the Neander-

thalian is flat, as is that of Pithecanthropus (*B*), while the endocast of the modern human type displays a distinct hump in the vertex region (*D*). Figure 80 demonstrates that this difference between the brain of modern man and that of his earlier phases is characteristic and always manifest, regardless of the size of the individual brain. The four zones between the different lines represent the range of the variations in the size of the endocasts (brains): the fine lines (Zone 1) indicate the anthropoids; the

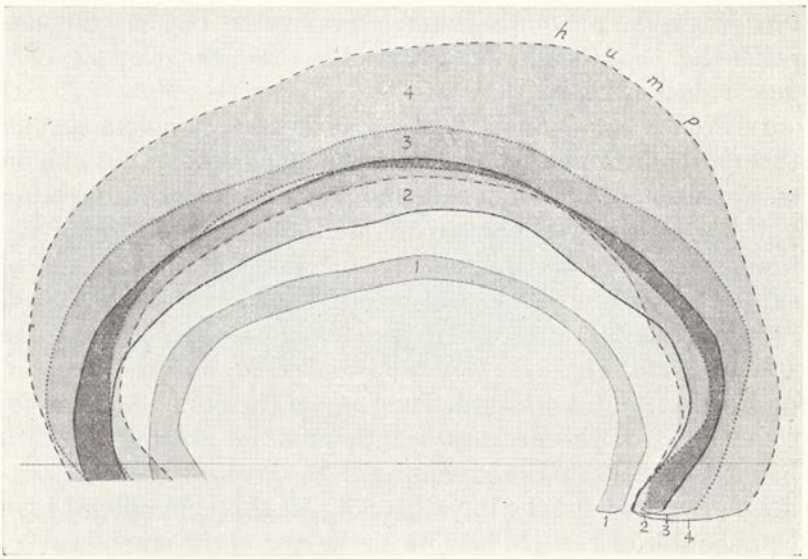

FIG. 80.—Diagram showing the observed ranges of the expansion of the brain cases of anthropoids (zone 1 between fine lines); Sinanthropus pekinensis (zone 2 between heavy lines); Neanderthalians (zone 3 between dotted lines); modern man (zone 4 between broken lines).

heavy lines (Zone 2), Sinanthropus; the dotted lines (Zone 3), Neanderthal man; and the broken lines (Zone 4), modern man. Note that the hump behind the vertex is apparent in the largest, as well as in the smallest, brain of modern man observed but that there is no corresponding hump in even the largest brain of Neanderthal man.

This extension of the brain in a vertical direction, achieved in the last evolutionary stage, seems, therefore, of more significance than the general enlargement of the brain. The increase

in height affects chiefly the parietal lobes, the posterior region of the inferior part of the temporal lobes, and, to a smaller extent, the posterior region of the frontal lobe. Figure 81 shows sections of endocasts, in lateral view, comprising the entire temporal and occipital lobes, the lower part of the parietal lobe, and a part of the cerebellum region. Figure 81 (*A*) is the fragment of an endocast of a Sinanthropus skull, with a capacity of about 1,000 cc.; (*B*) the corresponding fragment of the Neanderthalian Gibraltar skull, with a capacity of 1,250 cc.; and (*C*) the corresponding fragment of a native of New Britain, with a capacity of only 935 cc. These figures prove that the differences are not only those of size but also, and more emphatically, those of form. Although the brain of the New Britain native is much

FIG. 81.—Parts of endocranial casts representing the same areas of the brain surface. Sinanthropus pekinensis Skull V—*ca.* 1,000 cc. (*A*); Gibraltar skull—*ca.* 1,250 cc. (*B*); native of New Britain—*ca.* 935 cc. (*C*).

smaller than that of the Gibraltar man and even smaller than that of Sinanthropus, the brain of the modern human type is distinctly higher, in relation to the length, than that of the two types of early man.

Experiments have shown that certain areas of the cortex of the brain have a limited but quite specific function and that no fundamental difference exists between anthropoids and modern man in regard to these localizations. Figure 82 is the diagram of the lateral surface of a modern human brain in which the known cortex localizations are marked by dots. The location, extension, and arrangement of these areas are about the same as in anthropoids; but the expansion of the human brain has provided large new areas which lie outside of the localization zones in all four lobes (not dotted in the diagram). According to neurologists and psychologists, all these areas in the posterior parietal region, in

the inferior temporal region, and in the frontal region represent areas of association and are the expression of the high degree of the "encephalization" of the human brain. In other words, they are the seats of activities which are considered the most characteristic manifestations of human mentality. As G. Elliot Smith puts it: "The temporo-parietal area is the storehouse for the memories of the states of consciousness compounded of visual, auditory, and tactile sensations, and its progressive growth and specialization is the measure of the efficiency with which it performs these functions. The central area is the store-

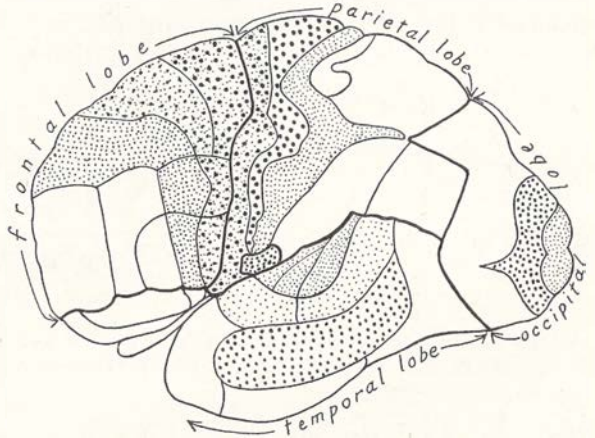

FIG. 82.—The left lateral surface of a human brain, showing the four lobes and the areas with known localizations (*dotted*). (After K. Kleist.)

house for the memories of actions . . . . the prefrontal area is concerned with attention and the orderly control of the psychical activities of the whole cortex. . . . ."

Yet, whatever the special functions of the newly acquired brain substances may be, one consideration should not be set aside. We know not only that the enlargement of the mass of the human brain is typical of the phylogenetic development of that organ but that this is also true regarding the extension of the brain surface, as manifested in plication or fissuration. This process is again paralleled by an increase in the thickness of the cerebral cortex—that is to say, an increase of the number of its cells and their differentiations. In studying the evolution of the

human brain on the basis of what its bony case reveals, one has to realize that all these cortex structures can be developed without any enlargement of the brain case and without leaving any trace on the inside of the cranial cavity, or, at best, only an indistinct one, so far as the fissuration is concerned (see Figs. 79 and 81). The most important achievements in the phylogenetic development of the brain, therefore, escape our observation. It is probable that they began their development on a full scale only when the brain had reached a certain size and that they occurred in lieu of further expansion. It would explain why the cranial capacity of modern man is not greater but is even smaller than that of his immediate predecessor, Neanderthal man.

The fact that mental qualities—at least those of a higher order—are hidden, so to speak, in the interior of the brain should make us cautious and suspicious of any attempt to read special mental qualities from the general form of the skull and head or from certain bony structures visible on their exteriors. It is human to believe that certain persons, such as gypsies, are able to read the character or the future of a given individual from the lines of the palm. Why, then, should not scientists be able to recognize innate talents or shortcomings of individuals or of entire races from the form of the skull bones?

One hundred and fifty years ago the first attempt was made in this direction. The German-French anatomist Gall advanced the theory that bumps on the outside of the head or skull indicate the special development of mental qualities, which are located in these regions of the brain. According to Gall, the top of the skull, from the front backward, for example, was the seat of morality, religion, firmness, and pride. This kind of phrenology did not long survive its author. But toward the end of the nineteenth century it flourished again, when the senses of mathematics and music were identified with pronounced swellings of certain parts of the cerebral surface and, therefore, under certain circumstances, visible or palpable even on the outside of the skull. Anatomists and neurologists studied the endocranial casts of Pithecanthropus, Sinanthropus, and Neanderthal man. From the smaller or larger bulgings of certain convolutions they felt themselves justified in concluding whether the types were

right- or left-handed and whether they had been able to develop an articulate language and other mental qualities. However, the trustworthiness of these interpretations has not been increased by shifting the signs from outside the walls of the brain case (Gall's clues) to the inside. The length of the alimentary canal of man varies between about 15 and 45 feet, but no physiologist has ever ventured to claim that an individual with a long intestine has a more effective digestion than one with a short intestine. In principle, it is against all that we know of the relation between function and structure of the organs to suppose that greater size guarantees superior function.

Yet this kind of "craniomancy" is petty compared to the bold implications which have been drawn from the general shape of the skull of modern mankind. About one hundred years ago the Swedish anatomist Anders Retzius found that the proportion between the breadth and the length of the brain case varies not so much between different individuals as between different human groups or races. This proportion can be expressed numerically by the so-called "skull, or head, index," that is, the breadth of the skull expressed in percentage of its length. There are skulls which are long and narrow, and others which are short and broad (Fig. 83). The first type is longheaded, or dolichocephalic; the second type is short- and roundheaded, or brachycephalic. In the first case the index is below 75; in the other case it is over 80. Skull forms between these limits are called "mesocephalic." The measurements and the index are easily taken from any skull or living individual. In addition, the index remains almost constant after infancy, a peculiarity which makes the index an easily recognizable criterion for the distinction of individuals. Since large groups of Mongolians have been found to be brachycephalic and Australian natives and Eskimos dolichocephalic, the index was also regarded by Retzius as useful in discerning races.

Deniker and Ripley were the two authors chiefly responsible for the establishment and definition of subdivisions of the white race based mainly on skull index and complexion. The fair, longheaded whites were called "Nordic" by Deniker, and Ripley gave the dark, roundheaded whites the name "Alpines." But

De Lapouge, a French sociologist, Ammon, a German journalist, and Röse, a German dentist, completed these characterizations by adding certain psychic qualities. In doing this, the complexion receded more and more into the background, until finally the shape of the skull remained the main criterion for

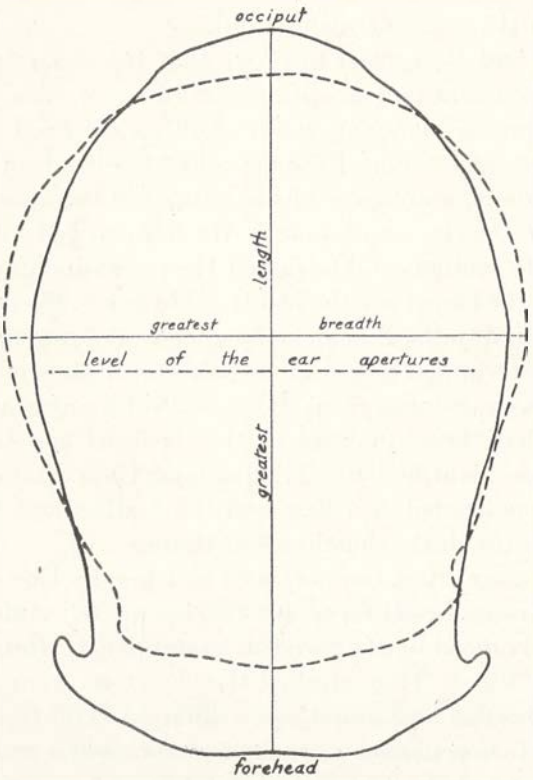

FIG. 83.—Outlines of an extreme dolichocephalic (*solid line*) and an extreme brachycephalic (*broken line*) skull of modern man viewed from above.

the determination of the physical and mental qualities of the individual.

Ammon said: "The long heads [dolichocephalics] of German descent represent the bearers of higher spiritual life, the occupants of dominant positions, to which they are destined by nature, the innate defenders of the fatherland and the social order. Their whole character predetermines them to aristocracy. . . . .

From purely scientific interests, to which the longheads are driven by their desire for knowledge and to which they devote all the impetus of their character, the round heads keep more aloof. Their inclination to the democratic theory of equality is due to the fact that they themselves do not exceed mediocrity and feel nothing but an aversion, if not hatred, against grandness which they cannot understand."[1]

Ammon and Röse tried to prove that the degree of the contrasting good and bad qualities, according to their judgment, depends upon a higher or lower skull index, even within the range of the same group. Röse measured the heads of university people, soldiers, employees of big industrial corporations, business leaders, clerks, and laborers. He summarized his results in the absolute sentence: "The higher the position and the greater the salary, the longer are the heads."[2] However, the moral qualities attributed to the European longheads and roundheads have not been determined by psychical analysis of known individuals but have been deduced from the records of Tacitus and Caesar, who ascribed these qualities to the Teutons and the Gallics. De Lapouge identified the Teutons and their characters with the fair, longheaded Nordics, and the Gallics and their characters with the dark, shortheaded Alpines.

But the claim that the northern and middle European longheads and roundheads represent two completely different races was first advanced by the Swedish anatomists G. Retzius (1900) and C. M. Fürst. They studied the skeletons from prehistoric tombs of Sweden and found three different skull types in all of them: a dolichocephalic, a brachycephalic, and a mesocephalic. A comparison of the material of the different ages showed that in the neolithic the longheads were in the majority by far and the roundheads in the minority (see Fig. 84); but their frequencies changed in the course of time, with a considerable decrease of longheads and a corresponding increase of roundheads. Since a high percentage of the present population of Sweden is longheaded (see Fig. 84) and of fair complexion, they identified the long neolithic skulls with the Nordics (Fig. 70), whom they

[1] Thesis No. 252, p. 185.

[2] *Arch. Rassen- u. Ges.-Biol.*, **2**: 181, 1905–6.

considered autochthonous, and identified the round skulls with an alien population, probably a dark complexion (Fig. 71), which had migrated to Sweden from the east in increasing numbers as time went on. The mesocephalic skulls were regarded as hybrids of the longheads and roundheads. The morphological identification was almost exclusively based on the comparison of the brain case and certain measurable features of the face, so far as the longheads were concerned; but most of the facial parts

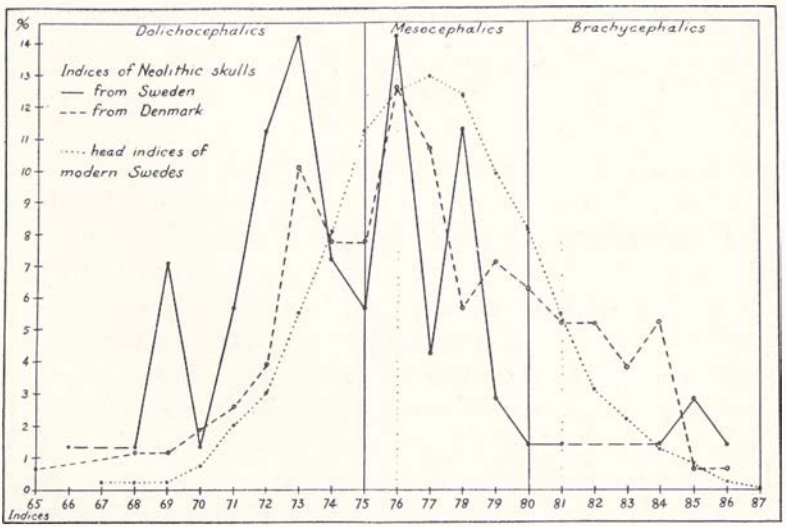

FIG. 84.—Curves indicating the range of skull indices of neolithic skulls from Sweden and Denmark and the frequency of the single indices in percentages. (According to G. Retzius and C. Fürst.) The same for the head indices of modern Swedes (draftees). (After Lundborg and Linders.)

of the neolithic round skulls were in pieces or were not distinct enough to define their special racial character. The frequency of the occurrence and distribution of the two races as they were found in Sweden was considered typical of all northern and middle Europe.

In Germany and in Switzerland there was found a great majority of longheads and a limited number of roundheads during the neolithic and early historic times, while the proportion became completely reversed in later times, so that today the overwhelming majority of the population in both countries is

brachycephalic and only a negligible minority dolichocephalic (Fig. 85). In other words, if the identification of the longheads with the Nordic race (Fig. 70) and that of the roundheads with the Alpine race (Fig. 71) is correct, the allegedly autochthonous Nordic race has been replaced in the last four thousand years by the alien Alpine race, which is, according to current opinion, of Mongolian origin and which migrated from central Asia to Europe. German anthropologists changed, therefore, the name

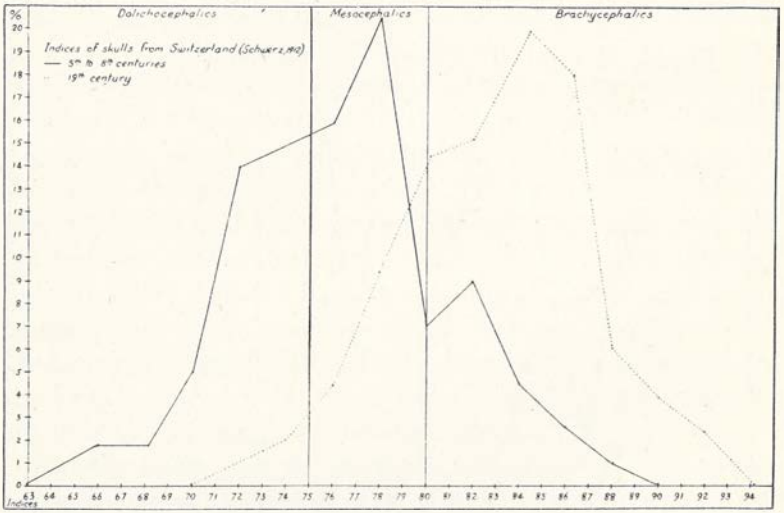

FIG. 85.—Curves indicating the range of skull indices and the frequency of the single indices in the "Reihengräber" type (fifth to eighth centuries) in Switzerland and those of modern man in the same country. (After Schwerz.)

"Alpine" race to "East" race in order to emphasize its Asiatic origin. Historical facts can possibly be produced to explain such an immigration; but, since they are not sufficient to explain the great number of the supposed newcomers—a number which reached a climax in and after the medieval period—a continuous, surreptitious infiltration was thought of rather than invasions made by force and on a large scale. For many years this "substitution theory" was fairly generally acknowledged; it was the basis of all speculations on superiority and inferiority of races, with all their social and political consequences. Ever since this racial theory was advanced, the main stress has been laid

on the shape of the brain case and the skull index, for complexion, which served as the second criterion in living races, was not applicable to skeletal parts. Whether the hair of the neolithic longheads of northern Europe was fair or dark and what its nuances, reaching from flaxen and platinum to dark blond, may have been, and whether the neolithic roundheads had black hair, like the Mongolians of today, or auburn, dark blond, or even fair hair, is not known. In any case, no race whatever can be defined by one character alone. In addition, the sharp separation of skulls in dolichocephalics, mesocephalics, and brachycephalics is entirely arbitrary, because each of these categories runs into the other without any break.

However, in the last ten years a surprising change in opinion has taken place. The last and most meticulous anthropological census of central Europe ever made, particularly for the central European population, brought to light the unexpected finding that the population is almost entirely roundheaded. The average index of Germany is 83.7; that of Austria, 83.4; that of Czechoslovakia, 87.4; that of Switzerland, 82.1; while the upper limit of dolichocephaly is 76.0 (cf. Gerhardt). In other words, as far as head index is concerned, the central European population is not longheaded and not Nordic, if this racial assignment is implied, but is pronouncedly roundheaded. If the desirable mental qualities are really bound to longheads, and the undesirable ones to roundheads, as has been surmised, the good qualities would be present in only a very small percentage of the central European population. The overwhelming majority would have only bad qualities.

To escape from these embarrassing alternatives, only one way was open: namely, to consider the roundheads not as foreign Asiatic elements but as having been developed originally from longheaded people and as being, therefore, of the same racial origin as the latter. The "substitution theory" has been replaced by the "transformation theory." Indeed, all facts point in the direction of the latter. The presupposition according to which only a longheaded population was settled in Europe in neolithic times is incorrect. There was already a considerable percentage of roundheads and mesocephalics all over Europe at

this time; Figure 86 (map) shows their distribution. Furthermore, if the roundheads originated in Asia and migrated in later prehistoric or early historic times from that continent to Europe, one must expect that in the supposed homeland of these emigrants and in the countries through which they trekked roundheads must have been massed, or at least were in the majority. But all that we know now of the skull forms of eastern

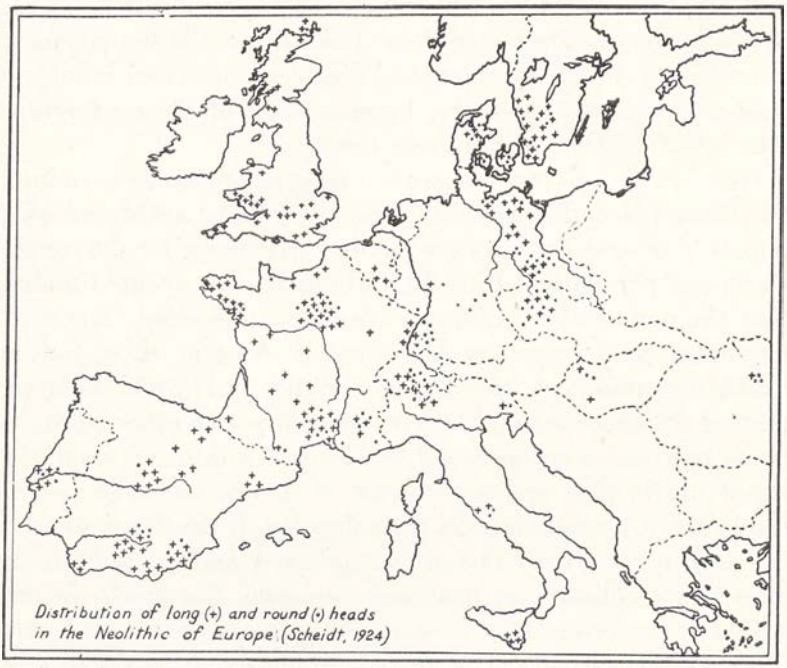

FIG. 86.—Map of Europe indicating the distribution of dolichocephalic (+) and brachycephalic (•) skulls in the neolithic of Europe. (After Scheidt.)

Europe, of western Asia, especially Asia Minor, and of central Asia during all the early times reveals that the dolichocephalics prevailed and that the brachycephalics were in the minority, exactly as has been reported regarding early Sweden or central Europe. The skulls which Sir Aurel Stein brought from the central Asiatic steppes and which have been partly attributed to Huns or other contemporary nomads are dolichocephalic and not brachycephalic (cf. A. Keith, 1929) and, therefore, cannot be presented as the ancestors of the roundheaded Alpine race.

Some years ago, the Polish anthropologist Reicher proved that the skulls of the roundheaded European population of today and those of the roundheaded central Asiatic population of today are almost identical, so far as the form of the brain case is concerned, but that they differ in the characteristic facial features, the former exhibiting the traits of Europeans and the latter those of Mongolians, regardless of the special form of the brain case. The famous Dutch neurologist, Ariëns Kappers, spent years of his life unraveling the relationship between the different brachycephalic types of Europe and those of the Near East, using the skull index as the only criterion. But even he was finally forced to admit that not all the roundheads of the earth can be traced back to the same source and that brachycephalics, particularly in the higher degrees, can develop quite independently of one another in any racial unit. This should have been clear from the beginning. Nobody ever advanced the theory that all dolichocephalics of the earth are related to each other and that such a relationship could be inferred from dolichocephaly alone.

The obvious tendency of the population of Europe to transform longheads to roundheads is not restricted to that continent or to the period of which we have spoken. It is an old and well-known fact that all the skulls of early man—Pithecanthropus, Sinanthropus, the different types of Neanderthalians, and almost all the paleolithic forms of recent man—no matter from which part of the world they have been recovered, are dolichocephalic, some of them pronouncedly so. Brachycephalics made their appearance in the upper paleolithic, but in a very small number. However, today, the overwhelming majority of the population of the earth is, according to the latest census figures, not dolichocephalic but mesocephalic and brachycephalic (see Figs. 87 and 88 [maps]). Brachycephaly prevails in the European and Asiatic continent and in Indonesia. The natives of Australia and Africa are dolichocephalic; those of America and Oceania are mesocephalic. But in all continents except Australia there are larger or smaller areas in which the other indices are in the majority. This proves that the form of the human skull never remained stationary but shifted from dolichocephaly

through mesocephaly to brachycephaly in historic times and apparently is still changing today.

The figures for the length and breadth of the skulls which are available for Germany and Switzerland from the Iron Age to the eighteenth century (Table 4) show that the length decreased and the breadth increased constantly. This proves that the skull index is not a constant factor which can be used as an infallible standard for the determination of races, relationships, and men-

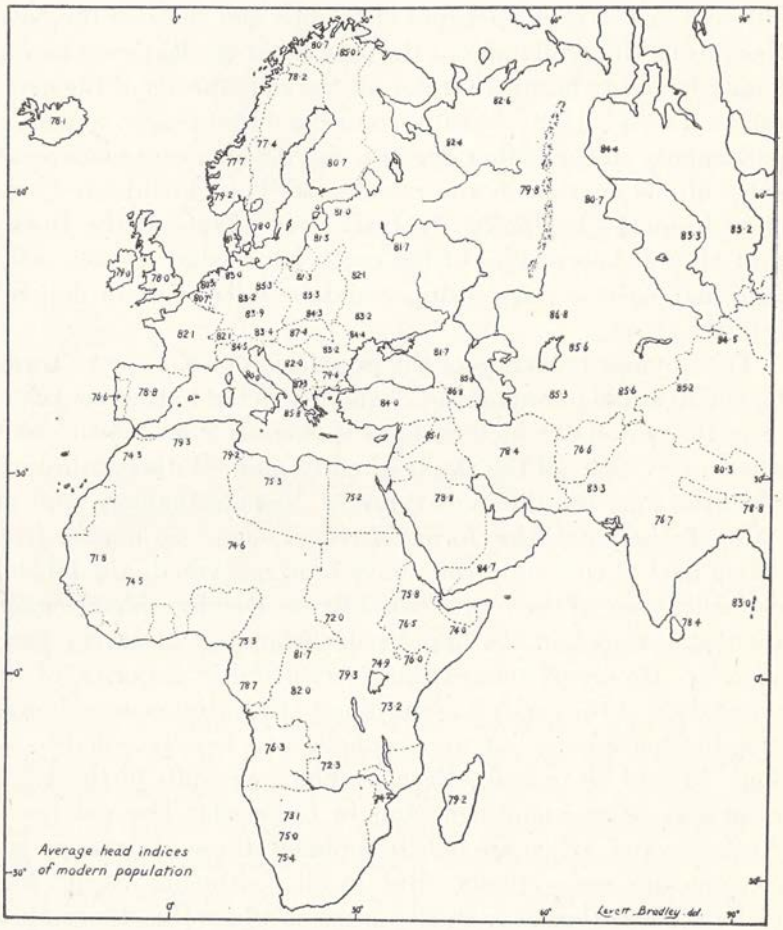

FIG. 87.—Map showing the average head indices of the recent populations of Europe, Africa, and western and Central Asia. (Calculated from Gerhardt's figures.)

tality. Its inconstancy, on the other hand, explains the relative ease with which the index can answer to environmental influences and explains the failure of every attempt to ascertain the manner of its inheritance. Furthermore, this inconstancy demonstrates how and why mesocephaly cannot be interpreted as a mere product of crossbreeding between dolichocephalics and brachy-

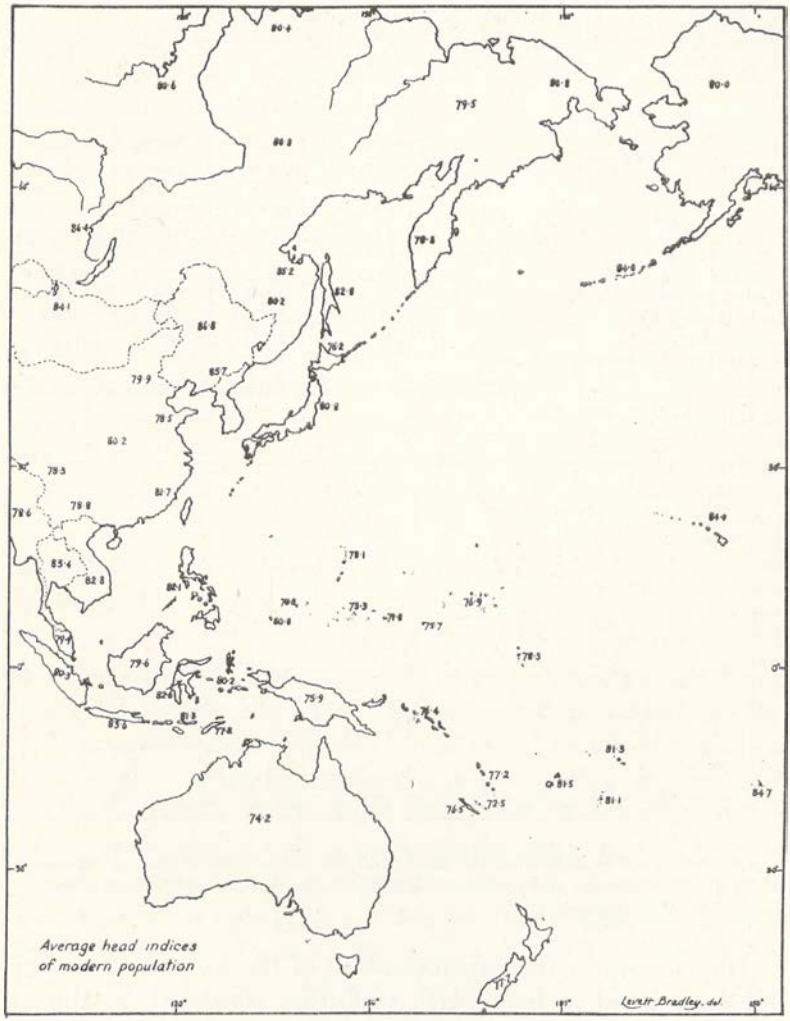

FIG. 88.—Map showing the average head indices of the recent populations of eastern Asia, Australia, and Oceania. (Calculated from Gerhardt's figures.)

cephalics, as is the general belief today, but must represent the same "distinct" form of the skull as dolichocephaly and brachycephaly. The entire "substitution theory," with all its consequences, is pure fantasy.

TABLE 4*

SHORTENING AND WIDENING OF THE BRAIN CASE OF SKULLS FROM SWITZERLAND AND SOUTHERN GERMANY FROM THE IRON AGE TO MODERN TIMES

PERIODS	SHORTENING		WIDENING	
	Skulls Shorter than 159 Mm. (Per Cent)	Skulls Longer than 190 Mm. (Per Cent)	Skulls Narrower than 124 Mm. (Per Cent)	Skulls Wider than 155 Mm. (Per Cent)
Iron Age	4.8	33.3	23.8	23.8
Roman period	3.9	44.2	18.2	16.9
Early medieval	7.4	57.4	41.3	10.4
Late medieval	4.0	12.0	20.2	28.0
Sixteenth to eighteenth centuries	43.5	12.1	3.9	39.1

* After E. Hug, 1939–40.

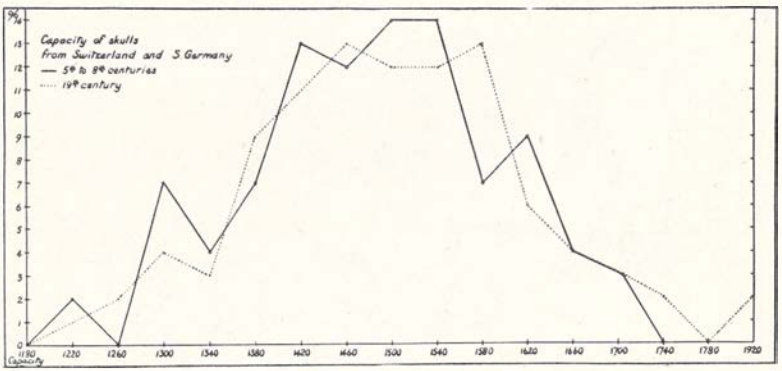

FIG. 89.—Curves indicating the range and the frequencies of cranial capacities of skulls from Switzerland and southern Germany, covering the same periods of time as in Figure 85. (After Schwerz.)

The characteristic transformation of the human skull which has gone hand in hand with evolution consisted, in the first phases, of an expansion of the brain case (Figs. 34 and 35). When the Neanderthal phase was reached, the expansion stopped and the further development of the brain case went in

the direction of brachycephalization. Indeed, the increase in breadth and the decrease in length, which were inseparable for the increase of the skull index, neutralized each other, as far as the cranial capacity was concerned. It has been repeatedly shown that there is no difference in capacity between longheads and roundheads within the same population (Fig. 89). Therefore, there must be another reason for the brachycephalization of the human skull. It is my belief that it is connected with the further adjustment of the head to erect posture (cf. Weidenreich, 1924); for the globular form of the brain case, with its tendency to equalize length, breadth, and height, is the most appropriate one for keeping the skull balanced on top of the spine (Fig. 90). The increasing brachycephalization is, therefore, an indication that evolution still goes on. That some races or some racial groups are more advanced than others fits in with this point of view. Yet it may not be superfluous to warn against using the degree of brachycephalization as a scale to gauge retardation or advancement of physical achievement.

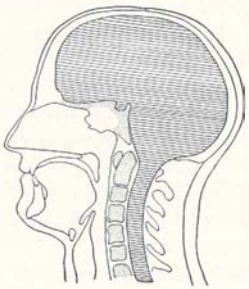

FIG. 90.—Mid-sagittal section through the head of man, showing the vertebral column and the skull base (*dotted*) and the spinal canal and the cranial cavity (*shaded*) in their topographical relation to each other.

The skull form is still less important as a clue for mental qualities, either of individuals or of whole physical groups. Even if the special shape should be considered only as a kind of symbol, it is meaningless, for there is a broad range of variation which brings contrasting forms closely together in one case while putting them widely apart in another. However, to interpret the brain case as only a shell manifesting the exact form of its contents, the brain, is anatomically and physiologically a complete misconception; for, since the brain case incloses its contents relatively loosely, the brain can possess a brachycephalic form even in a dolichocephalic brain case. Therefore, if a special type of mental quality were really to depend on the form of the brain, this could never be recognized by the shape of the bones which cover it.

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