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THE UNBALANCED DEVELOPMENT OF THE PHYSICAL FEATURES OF *SINANTHROPUS PEKINENSIS* AND ITS INTERPRETATION

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Thirty years ago, Choukoutien began to become world-famous by the discovery of the first skull of Peking Man——*Sinanthropus pekinensis*.

Choukoutien is a small town situated 48 kilometers southwest of Peking at the foot of the Western Hills. This town is known for its product, limestone quarried from the thick Ordovician bed that forms the structural backbone of the nearby hills. It is from the caves and fissures in these Ordovician limestones that the rich fossil remains were discovered.

From the beginning of the Choukoutien excavation in 1927 to the time when it came to a stop on account of the outbreak of the Anti-Japanese War in 1937, many human fossils probably of 40 individuals of *Sinanthropus* had been found, including 5 nearly complete skull vaults, 6 fragments of facial bones, 11 pieces of mandibles, 147 teeth, and 11 fragments of limb bones. Associated with them were a large amount of old stone implements and abundant evidences of the use of fire. Choukoutien has been one of the localities of the world richest in human fossils.

Unfortunately, all *Sinanthropus* fossils were tragically lost during the war.

Soon after the liberation of Peking in 1949, excavation at Choukoutien was at once resumed. In 1949 and 1951, excavations were carried out and 5 teeth and 2 fragments of humerus and tibia were recovered. But owing to the urgent need of studying the numerous emergent fossil finds during the nation-wide reconstruction work, large-scale excavations at Choukoutien were suspended in 1952—1957. However, it was resumed in 1958 and one mandible of *Sinanthropus* was discovered in July, 1959.

According to the results of the systematic studies on these fossil materials, *Sinanthropus pekinensis* possesses the following characteristic features:

The greatest breadth of the skull vault in *Sinanthropus* is low down on the side walls of the skull, just above the ears. The total height of the vault is much lower than that of modern man. The forehead is receding. The cranial capacity is calculated to be 1,075 cc on an average, while that of modern man is 1350 cc. The supraorbital ridges are enormous and protrude forward over the orbitals like a house-shelf. Another

peculiarity is the presence of a well-developed sagittal crest running down the middle of the skull from front to back, and on either side of it the parietals are flattened, giving a gable-shape to the vault. There is also a well-developed occipital torus, which not only extends across the entire occipital bone, but also is prolonged into the lateral mastoid region and is continued in a supramastoid crest. The sagittal crest, the occipital torus, and the supramastoid crest are all a part of the reinforcement system that forms the architectural framework of the skull. The cranial bones are almost twice as thick as those of modern man.

Teeth of *Sinanthropus,* crowns and roots alike, are much bigger than those of modern man. The crown of the molar is characterized by its lowness in relation to its length and breadth. The chewing surfaces of the premolars and molars are covered with complicated wrinkles of special patterns. Cingulum is very pronounced in the two canines and in all premolars and molars. The upper central incisor exhibits a strongly developed basal tubercle which continues to form several finger-like prolongations. The lingual surfaces of the upper central and lateral incisors are typically shovel-shaped with the borders markedly thickened and folded around lingualwards. The lower molars all have 5 or 6 cusps.

The face of *Sinanthropus* is extremely broad in comparison with its length. The nasal bones are much broader than those of modern man. The malar bones are sharply angled and frontally orientated. The chin region slopes sharply backward. There is no mental eminence such as is found in modern man. The lower dental arch is long and relatively narrow.

The *Sinanthropus* teeth and jaws and skulls are separated into two groups. Big teeth, heavy jaws, and very thick skull parts probably belong to males, while small teeth and thinner, more fragile bones to females. The size discrepancy between the males and females of modern gorillas and orang-utans is also enormous.

Up to the present, only a few extremity bones of *Sinanthropus* have been discovered as mentioned above. But even based on such a few specimens at hand, we can get an idea of the general characters of the *Sinanthropus* extremities.

The lower extremity bones (based on femur and tibia) are, in general, of modern type. The *Sinanthropus* femur is similar in length, robustness, proportion, and attachment of muscles to those of modern man. However, it possesses some peculiarities. The femur shaft of *Sinanthropus* shows in its upper half a distinct convexity of the medial border, like the femur shaft of the chimpanzee. The femur is slightly bent forward, with the apex of the bend below the middle of the shaft at the place of smallest circumference, while in modern man the constriction of the femur usually occurs at, or fairly near, the midpoint of the shaft. The absence of the muscular lines such as the linea intertrochanterica and linea pectinea in the *Sinanthropus* femur is also characteristic of modern big apes. The crista subtrochanterica extends upward to

the base of the great trochanter and forms at its termination a special protuberance called tuberculum hypotrochantericum, which is characteristic of the Neanderthaloid femur and absent in that of modern man.

The marked front-to-back flattening in the subtrochanteric region (upper fifth of the shaft) of the femur and the blunt anterior border and cross-section of the tibial shaft of *Sinanthropus* are reminiscent of modern apes.

The most striking characteristics of *Sinanthropus* femur and tibia are the extraordinary thickness of the walls and the narrowness of the medullary cavity. The medullary cavity of the femur is equivalent to 1/3 of the least diameter of the shaft while it is only equivalent to 1/2 of that in modern man. The spongy bones are more compact than those of modern man. The medullary cavity of the shaft of tibia is even narrower than that of femur.

The upper extremity bones of *Sinanthropus* so far found are two fragments of humerus, the medial half of a left clavicle and one piece of right lunate bone. They are all of modern type and even more similar to those of modern man than the lower extremity bones. The only primitive character retained is the narrower medullary cavity and the thicker walls of the humerus.

No axial skeleton of *Sinanthropus* has so far been found. But judging from the close relationship of the trunk and thorax to the limbs, especially the upper ones, it can be inferred that the axial skeleton is also similar to that of modern man. And Washburn (1951) separated the human body into three regions distinct in phylogeny, with arms and thorax the oldest, the bipedal complex of pelvis and legs later, and the head and face latest of all to reach their modern form.

The main features of the *Sinanthropus* femur are similar to that of modern man as mentioned above. The linea aspera is present and the humerus is shorter than the femur. These indicate that the *Sinanthropus* had adopted erect posture. The gluteal tuberosity of the femur lies on a level as high as that of the modern man and is not so low down as in the apes. It shows that *Sinanthropus* can make extreme extension of the thigh at the hip joint which is necessary for bipedal locomotion.

The stature of *Sinanthropus* was calculated by Weidenreich to be 156 cm in male on the basis of the length of the femur which is estimated to be 407 mm. By proportion the female stature is 144 cm according to him. So *Sinanthropus* has rather low stature. Soviet anthropologists suggested a higher stature for *Sinanthropus,* 162 cm for the male and 152 cm for the female.

From the foregoing description, we can have a general idea of the physical conditions of *Sinanthropus pekinensis*. That is, *Sinanthropus* can already adopt erect posture, has limbs and trunk fundamentally similar to those of modern man, but with an apelike head. As to the limb bones, the upper extremity of *Sinanthropus* is almost identical with that of modern man while the lower extremity, though similar to that of modern man, still pos-

sesses some primitive characters.

The physical features of *Sinanthropus* may be simply and figuratively said to have a body like that of modern man combined with a primitive and somewhat apelike head. Why *Sinanthropus* is such a queer character?

Some anthropologists and paleontologists considered the skulls and the limb bones found in Choukoutien belonged not to a single type of mankind. The French anthropologist M. Boule attributed the skulls to a primitive type and the limb bones to an advanced type which created the Choukoutien culture. And the skulls of the *Sinanthropus* were those of the captives fallen into the hands of head hunters belonging to the advanced type.

Now, let us have a look of other earliest hominids. Besides *Sinanthropus,* there is *Pithecanthropus erectus* found in Java, Indonesia. The first skull of *Pithecanthropus* or Java Man was discovered by the Dutch army surgeon Eugene Dubois in 1891 in Trinil near Java and in the next year a femur was found from the same locality. The femur is like that of modern man and indicates erect posture. Hence in 1894 it was named *Pithecanthropus erectus,* meaning erect ape-man. Between 1936 and 1941, portions of three skulls and two lower jaws of *Pithecanthropus* were unearthed by von Koenigswald. Furthermore, four femora with modern features were found in Layden, Java. Weidenreich was one of the anthropologists who doubted the validity of attributing the femora to *Pithecanthropus*. However, a recent report on the analysis of fluorine contents of these specimens showed that they probably all belonged to *Pithecanthropus*. That is to say, *Pithecanthropus erectus* also possesses a body like modern man with an ape-like head.

In the last ten years, a series of important discoveries were made in South Africa. Many new fossils of *Australopithecus* were uncovered. Whether *Australopithecus* can make simple tools is still disputable. Thus whether it is man-ape or ape-man can not yet be concluded. But at least it can be said that *Australopithecus* is the man-ape so far found closest to the remote ancestor of man. And it is interesting to note that the discovery of the pelves of *Australopithecus* indicates its upright bipedal posture but with an ape-like head. These forms have brains which are in the range of the living apes. Thus *Australopithecus* also has a man-like body forms with an ape-like head.

How to explain these phenomena?

British scientist de Beer in studying the famous fossil *Archaeopteryx* propounded the theory of "mosaic evolution" (1954). He pointed out that the common assumption of a general transformation of the whole animal in the evolutionary process from one class of animal to a higher class is not correct. It is compounded of a mosaic of characters, some of which still preserve almost entirely archaic characters while others have achieved more advanced state of a higher stage in their development. *Archaeopteryx,* found in the upper Jurassic stratum was generally recognized to be the most primitive bird evolved from the reptilian ancestor. It would be expected that it should possess characters intermediate between those of reptiles and birds. But this is by no means the

case. *Archaeopteryx* has reptilian characters such as simple brain with a small cerebellum, simple articulations between the vertebrae without any of the complications found in birds, and free metacarpals and metatarsals etc. on the one hand, and has distinct avian characters such as having feathers and arranged on the forearm to form a wing, fused clavicles and the hallux being opposable to the other three toes etc. on the other hand. Thus *Archaeopteryx* is characterized by a mixed instead of an intermediate condition between the reptilian and the avian classes.

Furthermore, de Beer pointed out that this mosaic mode of evolution applies to the transition between all classes of vertebrates. The Ichthyostegalia have median fins and lateral-line organs characteristic of fish on the one hand and have pentadactyl limbs characteristic of amphibia on the other. *Seymouria* possesses the articular bone and is long regarded as the most primitive known reptile, but it has recently been shown to have lateral-line canal grooves and was an amphibian. The Ictodosauria likewise show a mosaic of reptilian and mammalian characters. They possess quadrate-articular articulation, simple columella auris, with post-dentary bones in lower jaw, the presence of coracoid, procoracoid and interclavicle etc. characteristic of reptilians on the one hand and possess paired occipital condyles, bony false palate, large dentary with ascending ramus, differentiated teeth, the presence of olecranon process and acromion process etc. characteristic of mammals. So de Beer suggested the wide application of mosaic evolution as a general principle.

It is of great interest to note that this principle of the mosaic mode of evolution is thought applicable to the transition from the ape to man. *Australopithecus, Pithecanthropus* and *Sinanthropus* all show mosaic of features of modern man and modern apes.

How to explain these phenomena?

An organism is a functioning whole. Every part of the body is closely related to each other. But different parts of the body have different functions. Paleontologists have long held that the different parts of organisms are capable of more or less independent evolution, proceeding at different rates. A necessary consequence of evolution is the production of animals showing a mixture of primitive and specialized characters.

This unbalanced development of physical features seems to occur markedly at the transitional period of one class of vertebrates to another. Which parts of the body play the most important role in function and thus have the highest rate of evolution then at the transitional period?

Not long ago, it is generally believed that higher class of vertebrates has bigger brain than the class of animals below it. Thus the amphibians have bigger brains than the fishes, the reptilians, than the amphibians, and the mammals, than the reptilians. Generally speaking, this is true. But a wrong assumption has thus been evolved therefrom that the higher classes of vertebrates have triumphed over the lower ones because of better brains. However, Edinger (1948) showed that the earliest mammals did not have brains in advance of reptiles and that at least several of the orders of mammals had established locomo-

tor adaptation prior to having their characteristic brain forms.

The origins of the other classes of vertebrates seem also due to locomotor adaptations. In the evolution of these classes of vertebrates there has been in each case a clean-cut and sudden adaptation to a new medium: the partial and total conquest of dry land, and the mastery of the air. Thus locomotor adaptations had to be established at first, though a series of corresponding changes of other parts of the body did occur.

The earliest primates follow Edinger's pattern perfectly. They were distinguished from other primitive mammals by the use of the hands and feet for grasping. This is anatomically a complex adaptation, involving elongation of the digits, flattening of the terminal phalanges and thinning of the nails. This basic adaptation has been the foundation of the whole history of the primates, while the other differences in diet and dentition etc. are secondary characters. Thus, the origin of primates is also a locomotor adaptation.

This pattern of evolution also applies to the hominids.

The earliest hominids did not seem to have bigger brains than modern apes. The ranges of variation in cranial capacities of modern apes, *Australopithecus, Pithecanthropus* and *Sinanthropus* are given below:

Chimpanzee and gorilla	325— 650 cc
Australopithecus	450— 650 cc
Pithecanthropus	750— 900 cc
Sinanthropus	900—1,200 cc

Java man and Peking man are the earliest hominids so far found. But judging from their morphological features, their material cultures and the geological period, it can be ascertained that hominid and tools are older than Java man. Man is fundamentally different from animals, in virtue of his ability of making tools. Whether the Australopithecine can manufacture tools is not certain at present. Its pelvis, sacrum and femur, however, resemble modern man and indicate a biped upright posture. Yet it had rather small brain within the range of variation of the living apes. Thus bipedal locomotion was attained before the enlargement of brain. The big brain of modern man is achieved long after the use and manufacture of tools.

Man is different from animals in the ability of labor, in the use and making of tools.

Generally, we say that culture is characteristic of mankind and culture is made by man. One usually thinks of men anatomically much as our structure and in fact, men of our structure are the result of culture, attained in the long process of using and making tools.

The human radiation starts at the time when tools were first made and used for production and the large brain of modern man is the result of labour. There is evidence from the structure of the brain of modern man. Recently, Washburn (1959) also emphasized the effects of the use of tools to the brain.

Human brain is basically an enlargement of ape brain. But during the process of enlargement, different parts of the brain do not enlarge at equal rate. Different parts of the body are represented in the cerebral cortex (according to Pavlov's physiology, it is more accurate to say the cerebral cortical portion of the motor analizers) by different sizes of motor areas. The largest area represents functionally the most important and complex parts of the body. In the cerebral cortex of monkeys, the motor areas representing the hands and feet are of about equal size. But in that of man, the hand area is much larger than the foot area (fig. 1). These facts indicate that the enlargement of human brain happened after the manufacture and use of tools which caused the motor area controling the hand to enlarge and thus changed the proportions of hand and foot.

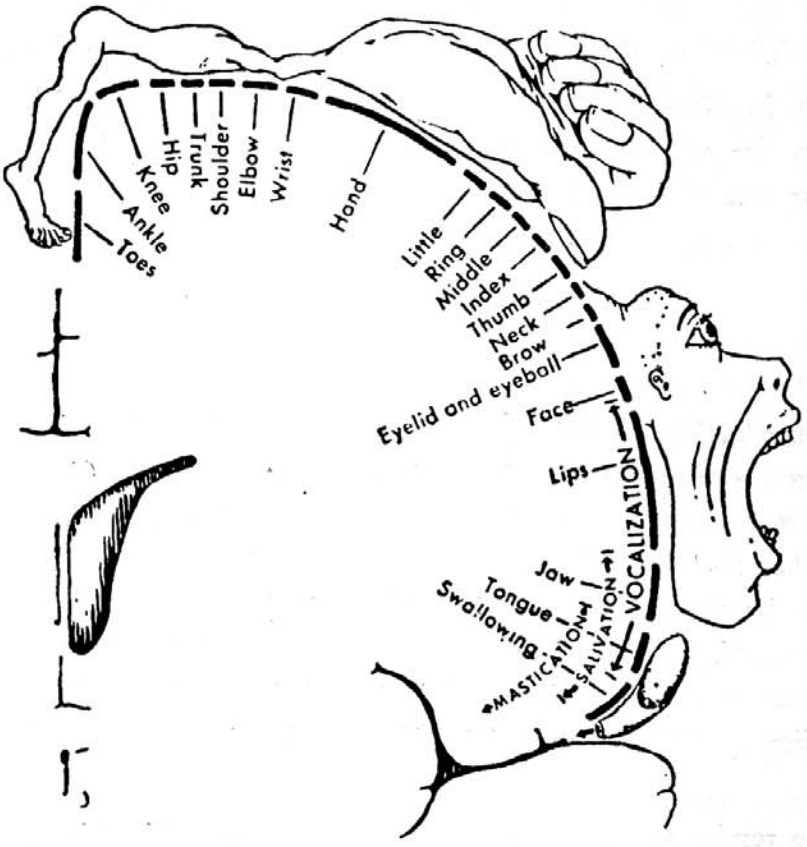

Fig. 1 Motor homunculus. The right side of the figurine is laid upon a cross section of the hemisphere. (From W. Penfield and T. Rasmussen: The Cerebral Cortex of Man, p. 57, Macmillan, 1950).

Besides, we can see from the accompanying diagram (fig. 1) that the motor area connecting with vocalization also has very large size. This is related to speech which is characteristic of man. The frontal lobe of human brain also enlarges greatly. This area is at least partially related with thought and consciousness. The earliest hominids used the simplest tools for food gathering and hunting. They had resort to mutual support and joint activity for the hardy subsistence. Thus the most primitive social organization was initiated. Mutual communication became necessary. They had

something to say to one another. From and in the process of labour, language was originated.

From the time of the use of natural objects such as sticks, stones etc. by the fossil apes to the time when tools were first made and used, in other words, to the time of the appearance of man on earth is a very long period. This is actually the period of transition from ape to man and the erect posture was probably achieved in this long process.

It should be mentioned in passing that in recent years reports on the new discovery of *Oreopithecus* from the Pontian stratum of Italy appeared. Hürzeler (1958) pointed out a number of its resemblances to man and his work aroused great interest. However, based on material so scanty, it can not be concluded at present.

Woo and Chia (1954) pointed out that the results of the study of *Sinanthropus* fossils gave evidence to Engels' theory of the transition from ape to man.

F. Engels, in discussing the source of wealth pointed out that labour is the primary basic condition for all human existence and thus derived that "in a sense, we have to say that labour created man himself."

Man originates on earth at the time when the most ancient tools were first made. Franklin defined that man is an animal who makes tools. Engels pointed out further that "the labour process begins with the making of tools" and that "no simian hand has ever fashioned even the crudest stone knife."

In the Introduction of "Dialectics of Nature", Engels said that "when after thousands of years* of struggle the differentiation of hand from foot, and erect gait, were finally established, man became distinct from the monkey .....". Here Engels clearly pointed out that the use of hand causes its differentiation from foot. Again Engels said that "step by step with the development of the hands went that of the brain". Thus the development of the brain is closely related to the differentiation of hand and foot. Engels went on to say that "the specialisation of the hand——this implies the *tool,* and the tool implies specific human activity, the transforming reaction of man on nature, production".

From the results of the study of the *Sinanthropus pekinensis* mentioned above, it is clearly seen that the upper extremity bones (probably together with the trunk bones) are almost identical with those of modern man; the lower extremity bones are in general similar to those of modern man but also possess some distinct primitive characters; and the skulls are much more primitive than those of modern man, the cranial capacity being much smaller. The upper extremity or hand, due to labour, differentiates first and foremost toward the direction of modern man. Owing to the operations of the hands, the upper extremity differentiates from the lower one and hence the latter lags behind the former in the development toward the direction of modern man. The differentia-

* According to the geological time-scale of today, millions of years would be more correct.

tion of extremities is followed by the development of the brain and the brain case, so the skulls and jaws still retain many primitive characters. The big brain of modern man is achieved in the long process of using and making of tools. The unbalanced development of physical features of *Sinanthropus pekinensis* therefore further proves Engels' theory of the transition from ape to man and testifies to the truth that "labour created man himself".

Though Engels' article on "The part played by labour in the transition from ape to man" was written in 1876, it has the same great practical significance today as ever. Engels analyzed explicitly the process of the formation of the idealistic view on labour. "By the cooperation of hands, organs of speech, and brain, ..., human bings became capable of executing more and more complicated operations, and ..... achieving higher and higher aims. With each generation, labour itself became different, more perfect and more diversified". In the process of labour human culture got rapid development, and the brain comes to play a greater and greater role. Thus arose the misconception that "in the face of all these creations, which appeared in the first place to be products of the mind, and which seemed to dominate human society, the more modest productions of the working hand retreated into the background, the more so since the mind that plans the labour process already at a very early stage of development of society, was able to have the labour that had been planned carried out by other hands than its own. All merit for the swift advance of civilisation was ascribed to the mind, to the development and activity of the brain. Men became accustomed to explain their actions from their thoughts, instead of from their needs and so there arose in the course of time that idealistic outlook on the world which, especially since the decline of the ancient world, has dominated men's minds. It still rules them to such a degree that even the most materialistic natural scientists of the Darwinian school are still unable to form any clear idea of the origin of man, because under this ideological influence they do not recognise the part that has been played therein by labour."

Therefore, it is of great significance to emphasize Engels' theory, which is important not only as a weapon for fighting the idealistic view on the origin of man but also for helping us to establish a materialistic idea on labour. This has great practical meaning in our socialist construction.

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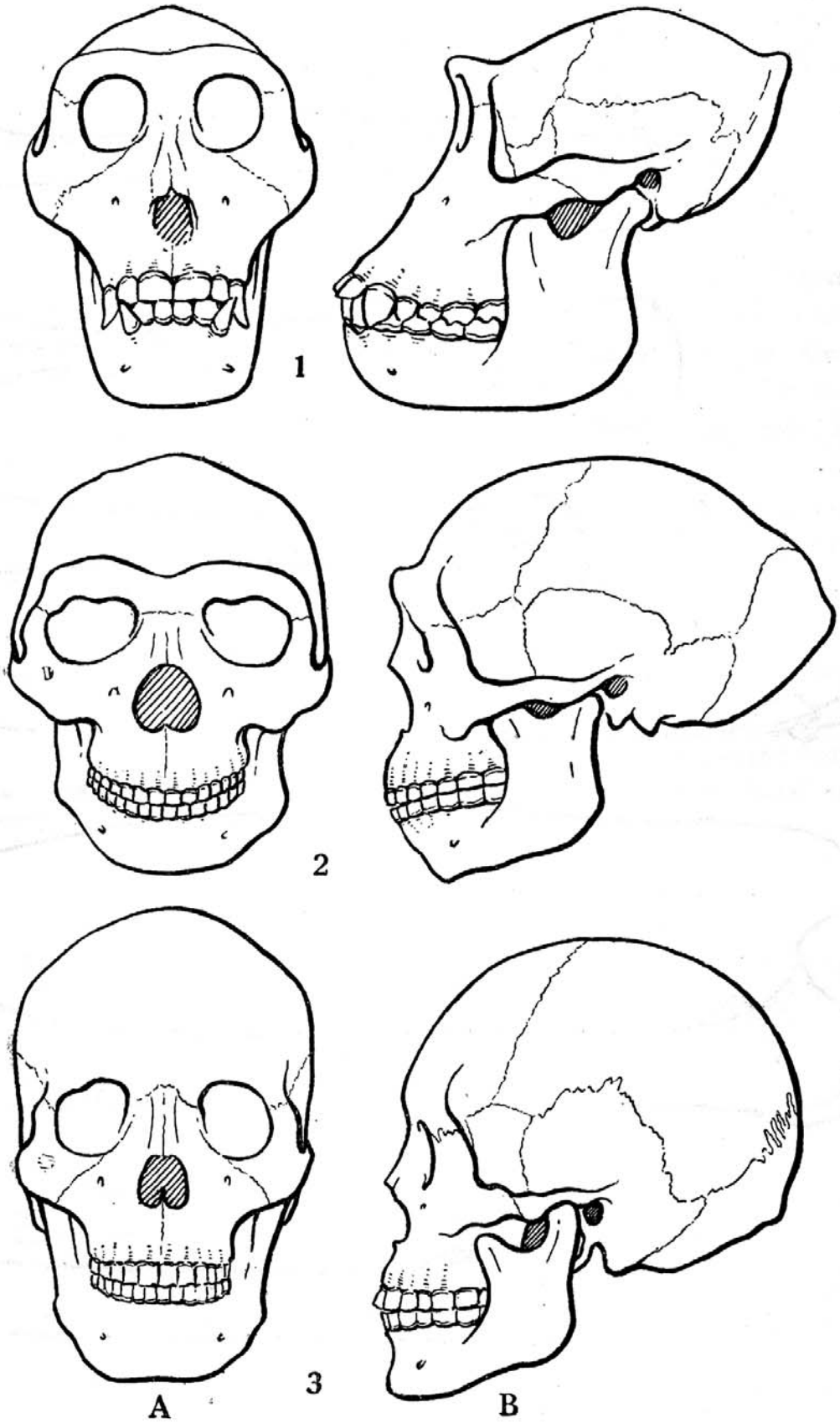
Explanation of Plates

Plate 1. Comparison of skulls.

1. Female gorilla, 2. *Sinanthropus pekinensis*, 3. Modern man. A. Frontal view, B. Left side view.

Plate 2. Comparison of limb bones (A. femur, B. humerus).

1. Chimpanzee, 2. *Sinanthropus pekinensis*, 3. Modern man.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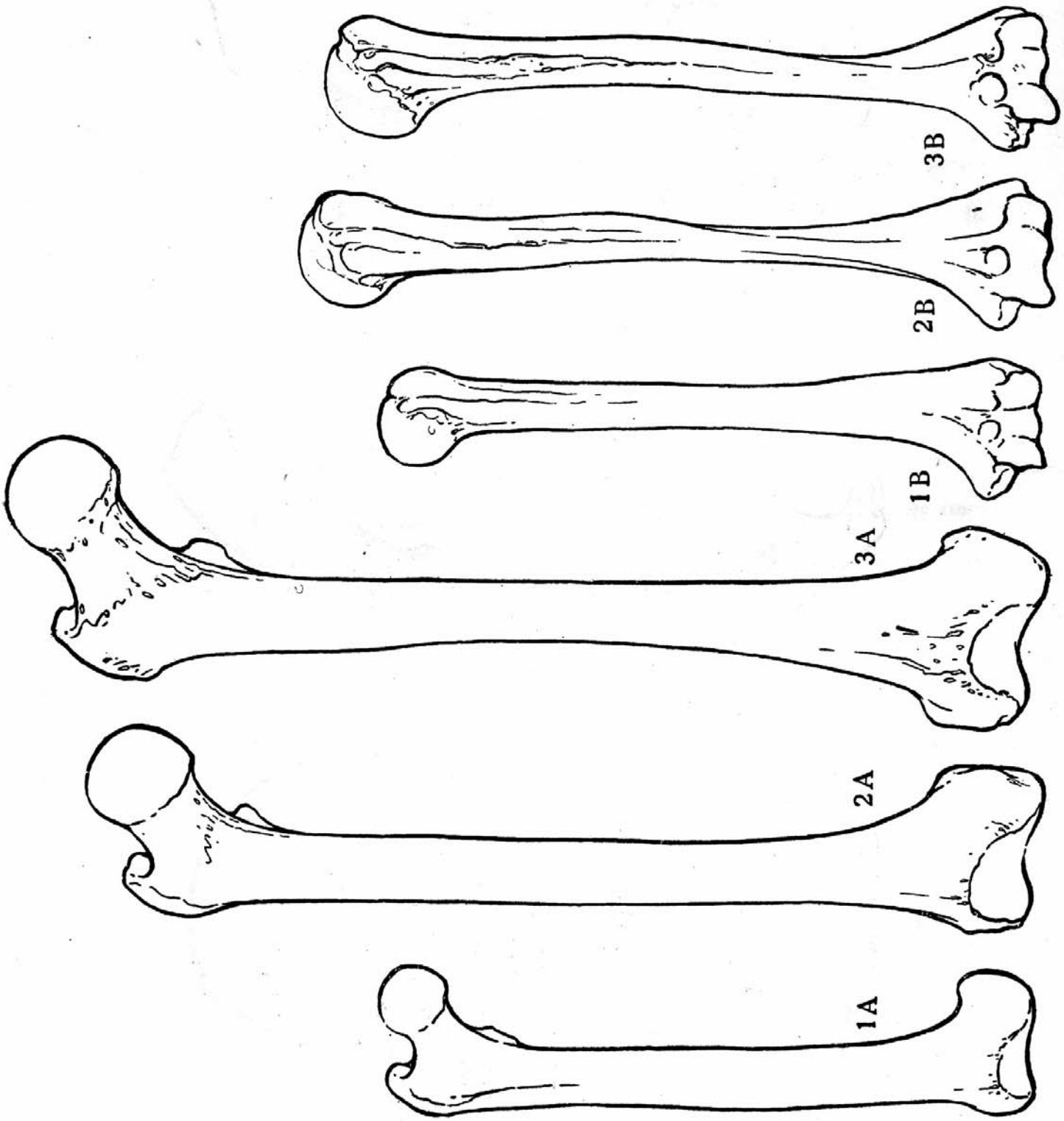
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