

*GIGANTOPITHECUS BLACKI* VON  
KOENIGSWALD, A GIANT  
FOSSIL HOMINOID FROM  
THE PLEISTOCENE OF  
SOUTHERN CHINA

G. H. R. VON KOENIGSWALD

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## PREFACE

IT IS WITH GREAT HESITATION that I have undertaken the description of the few isolated teeth of *Gigantopithecus* I collected in Chinese drugstores. Weidenreich has already published quite extensively on this gigantic primate that proved to be closely related to man rather than to the anthropoids. Since under present political conditions it is obvious that it will be impossible to obtain additional material in the immediate future, it seems advisable to avoid further delay in publication and to make all the known details available.

The reader will find that I share Weidenreich's interesting views on the relationship of *Gigantopithecus* only in part. The geological age of the finds, a factor easily underrated by morphologists, is not so early as suggested and is discussed in detail in one section of this paper since it is one of the principal points upon which they should be judged. Although I would prefer to deal with the primate group as a whole, particularly since a considerable quantity of material, mainly isolated teeth of a fossil orang, has been collected, this is impossible now because of the lack of time.

I am indebted to the Carnegie Institution of Washington, which for many years made it possible for me to visit Siam and China, especially to collect material from Chinese drugstores.

This publication forms part of a study of early man, undertaken in collaboration with Professor Weidenreich during my stay at the American Museum of Natural History, New York, with the assistance of grants from the Rockefeller Foundation and the Viking Fund (now Wenner-Gren Foundation for Anthropological Research). I am deeply obliged to both institutions for their generous support, as well as to the American Museum for its hospitality and for furnishing working facilities. My thanks are due especially to Dr. Harry L. Shapiro, Chairman of the Department of Anthropology, and to Miss Bella Weitzner who kindly assisted in preparing the present publication for the press.

G. H. R. VON KOENIGSWALD

Geological Institute  
Utrecht, Holland  
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## HISTORY OF THE DISCOVERY

MUCH OF OUR KNOWLEDGE of the fossil mammals of China is based on material obtained in drugstores, where it is a well-known practice to sell fossils for medicinal purposes. Three kinds of fossils are generally sold: brachiopods, crabs, and "dragon teeth." The brachiopods, mostly *Spirifer verneuili*, are of Devonian age, while the crabs are either Pleistocene or Pliocene. As might be erroneously concluded from the name, the dragon teeth are not the teeth of fossil reptiles, but the remains of fossil mammals that are systematically excavated for sale in the dispensaries. Since deer antlers are quite common among these finds, the Chinese dragon is decorated with a pair of antlers.

Davidson<sup>1</sup> in 1853 mentioned a small collection of brachiopods and mammal teeth bought in Shanghai by W. Lockhart; Owen<sup>2</sup> also had material from here as early as 1840; and von Richthofen<sup>3</sup> acquired a collection from Chinese boatmen on the Yangtze. This material, which is said to have come from Yunnan, was described by Koken<sup>4</sup> in 1885. Haberer accumulated a very large number of teeth in many of the large Chinese cities in 1900 for the museum in Munich; Schlosser<sup>5</sup> described some 60 species from this assemblage and drew special attention to a human upper molar that was obtained in a drugstore in Peking. It is this tooth that initiated the search for fossil man in the vicinity of Peking, resulting in the discovery of the Choukoutien site where Peking Man was found.

I had been acquainted with the Haberer Collection for many years, having been an assistant at the Museum at Munich. When I went to the East Indies in 1931 to join the Geological Survey I began to hunt for fossils in the Chinese drugstores in Java. Until I discovered, however, that I had made a grave mistake in simply inquiring about "teeth," my search in Bandung was unsuccessful. I should have asked for "dragon teeth," since that was the name of the "drug" I sought. When I finally learned the correct name and obtained a prescription, I succeeded in finding these teeth in every Chinese

drugstore in every Chinese community, not only throughout the East Indies (Java, Sumatra, Bali, Borneo, and Celebes), but also in the Philippines, Malaya, and Siam, and in San Francisco and even in Mott Street in New York City.

Most common is the Pliocene *Hipparion* fauna. Sometimes I found only selected teeth of the fossil horse *Hipparion richthofeni* and related species which, apparently because of their characteristic form, seemed to represent a widely known "trade mark." These were frequently mixed with the teeth of *Aceratherium*, large giraffes, and small antelopes, and often bore traces of red clay. These teeth are heavily fossilized and sometimes were deliberately damaged to expose the calcite crystals in the cavities, which apparently indicated first-grade quality to the consumer. It is obvious that complete skulls have been destroyed in order to separate the more valuable dragon teeth (*liung tse*) from the less desirable dragon bones (*liung khu*) which are also sold as medicine. Occasionally, we also found teeth of modern horses and cattle in large quantities, coming perhaps from Anyang, the old capital of Honan, where archaeological excavations have recently been made.

Koken's as well as Schlosser's material also contained Pleistocene forms including *Equus*. I found *Equus sanmeniensis*, the guide-fossil for the Nihowan fauna of northern China, in only a few drugstores in Shanghai. It was not until 1932 that Pleistocene material was recognized in the drugstores in Java. These Pleistocene teeth were not heavily fossilized and were clearly regarded as "second quality."

This Pleistocene assemblage differs from the Pliocene material not only in the species represented, but also in their peculiar state of preservation. Generally, all bony parts, including the roots of the teeth, had been gnawed by porcupines, so that only the crowns remained. There were no horse teeth, but many of the porcupine and pig. The porcupine is absent and the pig very rare in the *Hipparion* fauna. The Pleistocene fauna differs species for species. A complete account of this fauna is given below.

Such Pleistocene material was not plentiful in Java. It was not until early in 1935 that for

<sup>1</sup> Davidson, 1853.

<sup>2</sup> Owen, 1870.

<sup>3</sup> Von Richthofen, 1883.

<sup>4</sup> Koken, 1885.

<sup>5</sup> Schlosser, 1903.

the first time I came across a larger quantity of it in Manila. It was here, too, that I discovered the first teeth of a fossil orang-utan.

The orang is one of the most typical members of the recent Malayan fauna of Borneo and Sumatra. At the time of discovery the fossil history of this species was unknown; only a doubtful canine from the Siwalik Hills in India had been reported. We now had a fair chance of tracing the history of this interesting form. In Manila we were told that the orang-utan teeth had been purchased at a certain drugstore in Hong Kong. I went to Hong Kong where Prof. J. Shelshear was kind enough to offer me the aid of his Chinese assistants. Within two days we found several hundred orang teeth in the shops and were able to establish, with certainty, that the finds were derived from caves in the Kwantung and Kwangsi provinces of southern China.

Teilhard de Chardin and Pei obtained the same results independently. They had bought fossil orang teeth in a Chinese dispensary in Nanning, Kwangsi Province, which have been described by the latter.<sup>1</sup> Now it became evident that some curious teeth from Fuminhsien in Yunnan, attributed by Young<sup>2</sup> to “? *Aeluropus* sp.,” were also attributable to orang, thus making this interesting form known from three provinces of China.

Among the first lot of teeth obtained in Hong Kong was the molar of a higher primate that was not only much larger than any known tooth of orang, but was clearly different from that species. This molar, the first known example of *Gigantopithecus blacki* von Koenigswald, has become the type specimen.

In the original description, which was based on the single worn third lower molar, the author mainly pointed out the differences from orang, occurring within the same faunal association, in order to establish the independent position of *Gigantopithecus*. The tooth was compared with *Sivapithecus*; however, on the basis of the new material a closer connection with that genus must be dismissed.

The type specimen, here called Specimen 1, is the worn right lower third molar, obtained in

Hong Kong during my first visit in 1935 (Pl. 48e-g). In Hong Kong I obtained a right lower third molar in a drugstore near the Western Market (Specimen 2, Pl. 48h-j); it is very worn and, except for its size, bears no interesting details. During a second trip to southern China in 1935, I found a beautifully preserved upper molar in Canton (Specimen 3, Pl. 49a-d). Finally, in 1939, when returning from Peking, a virtually unworn left lower third molar came to light in Hong Kong (Specimen 4, Pl. 48a-d).

Without any doubt, the four molars belong to the same species and represent *four different individuals*. The rarity of this giant form is obvious from the fact that among approximately 1500 teeth of fossil orang collected, only four were molars of *Gigantopithecus*. The lower molars are a yellowish white, with light brown spots; the upper molar is slightly bluish, while the dentine is black. The matrix present in the open pulp cavity of the lower teeth is the typical yellow earth, the source of all the orang fauna. Pisolithic material filling the pulp cavity of the upper molar indicates that these four specimens come from at least two different localities.

In addition to these molars a number of other teeth might possibly be referred to *Gigantopithecus*. Four of them are here described in detail: an upper right central incisor; two last lower premolars ( $P_4$ ), a left and a right; and an upper canine. The incisor and the left lower premolar are the same yellow color as the lower molars and may possibly have come from the same site, or at least from the same type of deposit that yielded the lower molars. The right lower premolar is more bluish, but is not of the same color as the upper molar. In addition, an upper canine was found in a drugstore in Bandung in 1938.

Although my first study suggested that *Gigantopithecus* must be considered as an independent species,<sup>3</sup> Weidenreich<sup>4</sup> first referred it to a large orang, although later he modified his opinion and pointed out the human affinities of this giant. We will discuss this question below.

<sup>1</sup> Pei, 1935, 422, Fig. 6.

<sup>2</sup> Young, 1932a.

<sup>3</sup> Von Koenigswald, 1935, 874-875.

<sup>4</sup> Weidenreich, 1937, 145.

## THE AGE OF *GIGANTOPITHECUS*

THE MOLARS OF *Gigantopithecus* were obtained in Chinese drugstores, where they were associated with numerous teeth of orang (*Pongo* = *Simia*), giant panda (*Ailuropoda*), tapir, bear, rhinoceros, *Stegodon*, etc., apparently from the same source. The teeth are all in the same state of fossilization and the same curious state of preservation; the roots are virtually always missing, having been gnawed away by porcupines. Yellow earth frequently adheres to the teeth, indicating that they came from cave and fissure deposits. There was no suggestion whatever that any part of the material might have come from other sources, such as gravel or river deposits.

Most of the material observed, consisting of several cubic meters of isolated teeth, was accumulated in the large drugstores of Hong Kong, Canton, Macao, Batavia, and Singapore, not to mention the smaller establishments in many other towns in China and southeast Asia. The slight differences in color and matrix suggest that the otherwise uniform material may have come from many different sites rather than from a few large ones. In Hong Kong I was told that the material came from the interior of the provinces of Kwangsi and Kwantung. According to the literature the same fauna occurs in the provinces of Yunnan,<sup>1</sup> Szechwan<sup>2</sup> (Table 1), and Kiangsu<sup>3</sup> (Table 2). This fauna therefore must have had a very wide distribution inside China and may be contemporaneous with the fissures containing orang and *Stegodon* found by Fromaget and Saurin in Indo-China.<sup>4</sup>

The orang teeth, which are not rare in the drugstores, are generally found in the same lots with the teeth of the giant panda, *Megatapirus*, and *Stegodon*; *Elephas* is often present. The fact that these animals occur together in the same site was established by Bien and Chia,<sup>5</sup> in the cave of Hoshantung in Yunnan. To date, this is the only locality in which orang has been found *in situ* in China. In 1932, C. C. Young described a first lower premolar and a third upper molar of orang, erroneously labeled “? *Aelu-*

*ropus* sp.,” from this site. Bien and Chia mention five isolated teeth belonging to this anthropoid. In addition they report the occurrence of *Elephas* cf. *namadicus* in the same layer.

An identical fauna, with additional species but lacking orang, is found in Yenchingkou, Wanhsien, and in Szechwan. In 1920 Granger made a very large collection from this locality for the American Museum of Natural History.

Yenchingkou is a fissure deposit, and the fossils found there are not preserved in the same way as those purchased in the drugstores. Complete skulls and bones are not rare; from the material collected, it was possible to reconstruct a complete skeleton of *Bibos*.<sup>6</sup> The preservation of the bones in this particular site may be due to the local absence of porcupines (*Hystrix*), of which only a single jaw has been collected; hundreds of teeth belonging to this species have been found in the drugstore material. On the other hand, the bamboo rat (*Rhizomys troglodytes*), of which a series of skulls and jaws and part of the skeleton have been found in Yenchingkou, is absent from the drugstore material. A single tooth, which I originally referred to this species,<sup>7</sup> belongs to *Hystrix*. The rhinoceros, the proboscideans, the big tapir, the bear *Arctonyx*, *Cyon*, *Felis tigris*, *Viverra*, the gibbon *Bunopithecus*, and the langur monkey *Rhinopithecus* are the same in both faunas. The dissimilarity in preservation, therefore, is not a reason for regarding the Yenchingkou fauna as different from the “drugstore fauna” containing orang and *Gigantopithecus*.

The profile of the Hoshantung Cave<sup>8</sup> shows that the fossils occur below a “travertine crust” in a “calclitic yellowish-grey and loamy matrix,” approximately 2 meters thick. In addition to isolated teeth, a few jaw fragments and bones have been excavated, but like the roots of the teeth most of the bones have been gnawed by porcupines.<sup>9</sup> Exactly the same kind of deposit is found in the caves in Kwangsi, namely, a

<sup>1</sup> Young, 1932a.

<sup>2</sup> Matthew and Granger, 1923.

<sup>3</sup> Wang, 1931; Pei, 1939b.

<sup>4</sup> Fromaget and Saurin, 1936.

<sup>5</sup> Bien and Chia, 1938.

<sup>6</sup> The skeleton collected by Granger, according to information from Dr. E. H. Colbert, was all associated and represents a single individual.

<sup>7</sup> Von Koenigswald, 1935, 876, Fig. 26.

<sup>8</sup> Bien and Chia, 1938, Figs. 1, 2.

<sup>9</sup> *Ibid.*, 1938, Fig. 3.

TABLE 1

FOSSIL MAMMALS FROM CENTRAL AND SOUTHERN CHINA; DISTRIBUTION OF *Ailuropoda-Stegodon* FAUNA  
(SPECIES IN PARENTHESES WERE ORIGINALLY RECORDED WITH A DIFFERENT NAME.)

	Yunnan		Szechwan	Kwantung and Kwangsi	
	Koken, 1885 (Drugstores)	Young, 1932a; Bien and Chia, 1938 Hoshantung	Matthew and Granger, 1923; Young, 1939 Yenchingkou	Von Koenigs- wald, 1935 (Drugstores)	Pei, 1935 (Drugstores)
<i>Ursus kokeni</i>	(x) <sup>a</sup>	(x)	x	x	x
<i>U. augustidens</i>		x		x	
<i>U. praemalayanus</i>				x	
<i>U. sp.</i>				x	
<i>Ailurus fulgens</i>		x			
<i>Ailuropoda fovealis</i>		x	x	x	x
<i>Arctonyx rostratus</i>		(x)	x	x	(x)
<i>Cyon antiquus</i>			x	x	
<i>Viverra sp.</i>			x	x	
<i>Hyaena ultima</i>		x <sup>b</sup>		(x)	x
<i>H. sinensis</i>	x	(x) <sup>b</sup>	x		
<i>Felis tigris</i>		(x)		x	(x)
<i>F. sp.</i>		(x)		x	
<i>Hystrix sp.</i>		x		x	
<i>Rhizomys troglodytes</i>			x <sup>c</sup>		
<i>Lepus sp.</i>			x		
<i>Tapirus sinensis</i>	x		x	x	x
<i>T. augustus</i>		(x)	x	x	
<i>Rhinoceros sinensis</i>	x		x	x	
<i>R. sp.</i>	x			(x)	
<i>Chalicotherium sinensis</i>	x		x		
<i>Sus cf. lydekkeri</i>			x		
<i>S. sp.</i>		x	x	x	x
<i>Cervus sp. A</i>	(x) <sup>d</sup>	(x)	(x)	(x)	(x)
<i>C. sp. B</i>	(x) <sup>d</sup>	(x)		(x)	(x)
<i>Cervulus sp.</i>		x		x	x
? <i>Proboselaphus watasei</i>			x		
? Antelope			x	(x)	
<i>Gazella sp.</i>			x		
Ovidae sp.		x		(x)	
<i>Capricornis sumatraensis</i>			(x) <sup>e</sup>	x	
<i>Bibos geron</i>	(x)		x	?	
? <i>Bos cf. grunniens</i>			x		
<i>Bos sp.</i>		x	x <sup>f</sup>	x	x
<i>Mastodon sp.</i>			x <sup>g</sup>		
<i>Stegodon orientalis</i>	x		x	x	(x)
<i>Stegodon sp.</i>		x			
<i>Elephas cf. namadicus</i>		x	x	x	
<i>E. sp.</i>		x	x	x	(x)
<i>Macaca sp.</i>		x		x	
<i>Rhinopithecus tingianus</i>			x	(x)	
<i>Hylobates cf. lar</i>				x	
<i>Bunopithecus sericus</i>			x	x	
<i>Pongo cf. satyrus</i>		x		x	x
<i>Gigantopithecus blacki</i>				x	

<sup>a</sup> Determined by Koken as *Ursus sp. aff. japonicus*.<sup>b</sup> The *Hyaena* from this locality is *H. sinensis*, according to Young; *H. ultima*, according to Bien and Chia.<sup>c</sup> Probably not fossil.<sup>d</sup> Perhaps identical with *Cervus (Rusa) orientalis* Koken and *Cervus (Rusa) leptodus* Koken.<sup>e</sup> ? *Nemorhaedus sp.*<sup>f</sup> *Bubalus cf. brevicornis*.<sup>g</sup> From the same region, but a different site (Young, 1932a, 330).

"yellowish deposit" in which the teeth occur under a thick layer of "stalagmite." Sections of caves near Wuning and Hsignan, north of Kweiling, have been studied by Teilhard, Young, Pei, and Chang.<sup>1</sup> In the Wuning Cave the yellow deposit attained a thickness of 8 meters; in Kwangsi, according to these investigators, fissures with "yellow deposits" were also observed near Naping. The fauna from Tanyang<sup>2</sup> came from a cave, but no details about the locality or the excavations are given in the publication.

In Yenchingkou open pits or fissures are mined by the Chinese to obtain fossils for sale in the drugstores. A description of the method used and excellent photographs of the pits were published in a popular account by Granger.<sup>3</sup> In this region there are several indications that the fissures are not all of the same age. Young<sup>4</sup> obtained a *Mastodon* tooth from the locality which "was presumably found in a fossiliferous fissure too." As no *Mastodon* is known from the Pleistocene of China, this might be interpreted as an indication of the probable presence of Pliocene fissures. *Rhizomys troglodytes*, absent in the drugstore assemblage, occurs in the prehistoric site of Anyang,<sup>5</sup> and could be a recent species. Describing a microfauna from Yenchingkou consisting of 17 species, not collected *in situ*, Young<sup>6</sup> remarks that

all these forms, with the probable exception of *Rhizomys troglodytes*, are still living in Szechwan. . . . Some of the elements of the microfauna [*Rhizomys troglodytes*, *Tamias asiaticus*, and *Pteromys cf. xanthipus*] are distinctly in the state of fossilization as the undoubted representatives of the Pleistocene fauna. . . . The others look suspiciously fresh.

The mammals so far described are listed in Tables 1 and 2. By far the richest fauna comes from the drugstores in the south, but owing to lack of time it was possible to identify only a part of the collection. The fauna from Hoshantung does not include many species, but orang was found *in situ*. The fauna from Kiangsu Province is poorest but belongs to the same group.

As a whole, the fauna gives the impression of

<sup>1</sup> Teilhard, Young, Pei, and Chang, 1935, Figs. 11, 12.

<sup>2</sup> Pei, 1940.

<sup>3</sup> Granger, 1938.

<sup>4</sup> Young, 1939, 337.

<sup>5</sup> Teilhard and Young, 1936, 13.

<sup>6</sup> Young, 1935.

TABLE 2  
CAVE FAUNA OF CHEKIANG AND KIANGSU

	Kiangsen, Chekiang; Wang, 1931	Tanyang, Kiangsu; Pei, 1940
<i>Ursus</i> sp.	x	x
<i>Arctonyx</i> cf. <i>rostratus</i>		x
<i>Paguma larvata</i>		x
<i>Hyaena ultima</i>		x
<i>Hystrix</i> cf. <i>subcristata</i>		x
<i>H. kiangsenensis</i>	x	
? <i>Epimys rattus</i>		x
<i>Tapirus</i> cf. <i>augustus</i>	x	
<i>Rhinoceros</i> sp.	x	x
<i>Sus</i> cf. <i>paludosus</i>	x	
<i>Sus</i> sp.		x
<i>Cervus</i> ( <i>Rusa</i> ) sp.	x	x
<i>Cervulus</i> aff. <i>lacrymans</i>	x	
<i>Cervulus</i> sp.	x	x
? <i>Hydropotes</i> sp.		x
<i>Bos</i> sp.	x	x
<i>Stegodon</i> sp.	x	
<i>Elephas</i> cf. <i>namadicus</i> sp.		x
<i>Macaca</i> sp.		x

being quite modern, as it contains only three extinct genera, namely, *Gigantopithecus*, *Chalicotherium*, and *Stegodon*.

*Chalicotherium* is an archaic form from Yenchingkou known from a single isolated molar. Young has suggested that it might have come from an older deposit.<sup>7</sup> The exact source and horizon of Koken's and Owen's material are also unknown. Generally *Chalicotherium* seems to have become extinct in the Lower Pleistocene; the last representatives are known from Nihowan in North China, the Djetis fauna of Java, and the Pinjor horizon of India. *Stegodon* occurs in Java until the Upper Pleistocene and at least until the Middle Pleistocene in India.

*Hyaena* is still living in Africa. The species from Yenchingkou was referred to *Hyaena sinensis* by Matthew and Granger and to *Hyaena ultima* by Pei. The first species, type locality Choukoutien, should be older than the latter, but Dr. E. H. Colbert, working on the description of the Yenchingkou collection in the American Museum of Natural History, has informed me that according to his studies both species represent a single form, *Hyaena sinensis*.

All the other forms, as already stated, are

<sup>7</sup> Young, 1939, 331.

TABLE 3  
RIDGE-PLATE FORMULA OF *Stegodon*

<i>Stegodon orientalis</i>					
Yenchingkou	Dp3	$\frac{5+}{5+}$	Dp4	$\frac{6+}{7+}$	M2 $\frac{8+}{9+}$ M3 $\frac{8-11+}{10-13}$
Hoshantung	Dp3	$\frac{5-}{5+}$			
<i>Stegodon trigonocephalus</i>					
Trinil beds, Java	Dp3	$\frac{5-6}{5-6}$	Dp4	$\frac{7-9}{7-9}$	M2 $\frac{9-11}{9-11}$ M3 $\frac{12-14}{13+}$
<i>Stegodon insignis ganesa</i>					
Boulder Conglomerate and Narbada beds, India	Dp3	$\frac{5-6}{6}$	Dp4	$\frac{7+}{7-9}$	M2 $\frac{7-8}{9+}$ M3 $\frac{11}{11-13}$
<i>Stegodon pinjorensis</i>					
Boulder Conglomerate, India					M3 $\frac{14-15}{14-15}$
<i>Stegodon bombifrons</i>					
Dhok Pathan horizon, India	Dp3	$\frac{4}{4}$	Dp4	$\frac{5-6}{5-7}$	M2 $\frac{6-7}{7-8}$ M3 $\frac{7-9+}{8-9+}$

very similar to recent species, and some are even identical with them. The bears are of a modern type; one species might even be the ancestor of the modern Malayan bear. *Ailurus fulgens* is still living in western China, and *Ailuropoda* differs but little from the modern giant panda. The tiger belongs, as Hooijer<sup>1</sup> has shown, to the group of living tigers, and *Cyon*, *Arctonyx*, and *Viverra* are only slightly different from the modern species. This is also true of *Tapirus sinensis* which is closely related to *Tapirus indicus*. *Bibos geron* could be a Chinese race of the Indian gaur. The various species of deer and pig are of a modern type. The large *Tapirus*, or *Megatapirus*, *augustus* belongs, however, to an extinct group.

*Bunopithecus* is a gibbon with Malayan affinities; no gibbons now live in China. *Rhinopithecus* is still found in western China. The fossil orang, of which I collected close to 1500 isolated teeth in the drugstores, seems to be more variable than the living species. Whether or not it merits a new name can be decided only after a more careful study of the material.

According to the title of the first publication dealing with the material from Yenchingkou, Matthew and Granger<sup>2</sup> regarded the fauna as

Pliocene. In the conclusions of that paper, however, they were less positive:

The abundance of *Stegodon* and entire absence of *Elephas* and the presence of *Chalicotherium* are the only indications of Pliocene age; for the most part the fauna appears to be quite closely related to modern species and might well be considered Pleistocene.

Matthew was unable to complete the final description of the fauna, but, according to a note published by Colbert,<sup>3</sup> Matthew later revised his opinion and placed the fauna in the Pleistocene. The absence of *Elephas* in this collection is accidental, as was shown by Young.<sup>4</sup>

By far the most useful fossils for the determination of the geological age are the remains of the proboscideans. A large collection of *Stegodon* material from Yenchingkou has been illustrated by Osborn.<sup>5</sup> An isolated lower deciduous molar from Hoshantung, described by Bien and Chia,<sup>6</sup> is indistinguishable from the same tooth from Yenchingkou.<sup>7</sup> The teeth I found in the various drugstores are of the same type but, except for

<sup>3</sup> Osborn, 1942, 1452.

<sup>4</sup> Young, 1939.

<sup>5</sup> Osborn, 1942.

<sup>6</sup> Bien and Chia, 1938, Fig. 12.

<sup>7</sup> Osborn, 1942, 878, Fig. 761.

<sup>1</sup> Hooijer, 1947.

<sup>2</sup> Matthew and Granger, 1923, 597.



TABLE 4  
RIDGE-PLATE FORMULA OF *Elephas*

<i>Elephas cf. namadicus</i>				
Yenchingkou	Dp2 $\frac{4}{-}$	Dp3 $\frac{8+}{9+}$		
Hoshantung			Dp4 $\frac{-}{11}$	
Tanyang			Dp4 $\frac{8}{-}$	
<i>Elephas namadicus</i>				
Narbada beds, India			Dp4 $\frac{-}{10}$	M3 $\frac{14-15}{15-16}$
<i>Elephas cf. namadicus</i>				
Trinil beds, Java		Dp3 $\frac{-}{8+}$		M3 $\frac{19}{17-18}$
<i>Elephas hysudricus</i>				
Boulder Conglomerate, India		Dp3 $\frac{5+}{7-9}$	Dp4 $\frac{7-8+}{9}$	M3 $\frac{17+}{17-18}$
<i>Elephas planifrons</i>				
Pinjor horizon, India	Dp2 $\frac{4}{-}$	Dp3 $\frac{6+}{6+}$	Dp4 $\frac{6+}{7+}$	M3 $\frac{8-12+}{8-14+}$

the first deciduous premolar, not a single specimen is complete.

If we examine Table 3 in which the *Stegodon* ridge formula is given, it is evident at once that the largest number of ridges is to be found in *Stegodon trigonocephalus* from Java and *Stegodon pinjorensis* and *S. insignis ganesa* from India. The Javanese specimens are in many cases indistinguishable from those from China, as is the third upper molar from China illustrated by Osborn,<sup>1</sup> compared with the same tooth from Kendeng Brubus in Java.<sup>2</sup> The Chinese specimens are larger than those from Java, but their degree of specialization is precisely the same. The Pliocene stegodons all have a much lower ridge formula.

The affinities of *Stegodon orientalis* lie with the younger forms from Java and India. They point to a Middle Pleistocene age for the deposit.

The *Elephas* material from China is very scanty. There are a few teeth from Yenchingkou,<sup>3</sup> Hoshantung,<sup>4</sup> and Tanyang.<sup>5</sup> Although

they are deciduous teeth, they agree completely in the ridge-plate formulas as well as in the height of the crowns, proving that they all belong to the same type. The collection gathered in drugstores includes a few fragmentary deciduous molars from unknown localities but of the same type as the material already described from China. Fragments of isolated lamellae belong to high-crowned molars; the largest one is 74 mm. high.

Chinese authors have already recognized the Chinese elephant as *Elephas cf. namadicus*; additional material in my collection confirms this determination. The presence of this species, which is typical for the Middle Pleistocene in India and Java, indicates that the *Ailuropoda* and *Stegodon* fauna of China is of the same age. It will be noted that I arrived at the same conclusion in discussing the advanced form of *Stegodon*.

The fauna of South China, like that of Java, lacks the horse, *Equus*. Both faunas include *Ursus*, *Tapirus*, *Bibos*, *Stegodon*, *Elephas*, *Hylo-*

<sup>1</sup> Osborn, 1942, Fig. 762.

<sup>2</sup> Soergel, 1914, Pl. 1, Fig. 2.

<sup>3</sup> Young, 1939, Figs. 5-6.

<sup>4</sup> Bien and Chia, 1938, Fig. 11.

<sup>5</sup> Pei, 1940, Fig. 8.

TABLE 5  
FAUNAL CORRELATION

	Java	India	South China	North China
Middle Pleistocene				
Second interglacial	Trinil	Lower Narbada	Yenchingkou and fissures	Choukoutien
Second glaciation		Boulder Conglomerate	—	—
Lower Pleistocene				
First interglacial (and older)	Djetis	Pinjor	—	Nihowan

*bates* (= *Bunopithecus*), *Macaca*, and *Pongo* and belong to the same "Sino-Malayan province" which in China is known only south of the Tsingling Mountains.

The northern equivalent of the southern *Stegodon* fauna is to be found in the famous *Sinanthropus* layers of Choukoutien. Its position can be understood only in connection with the Sanmenian fauna of Nihowan. *Aceratherium*, *Mastodon*, and giraffes have disappeared, but we find the first true horse, large cattle (*Bison*), and modern types of carnivores (*Canis*, *Ursus*, *Lutra*, *Lynx*). *Hyaena licenti* is more primitive than *Hyaena sinensis* from Choukoutien or Yenchingkou. Pei, who originally regarded Yenchingkou as older than Choukoutien, later revised his opinion and now regards them as contemporary deposits.<sup>1</sup> Teilhard expressed the same opinion.<sup>2</sup>

The Nihowan fauna corresponds to the Djetis fauna of Java and the Pinjor horizon of India.

A correlation of the various faunas is given in Table 5.

This correlation is not entirely new. The same or similar views have been expressed by Colbert,<sup>3</sup> Teilhard,<sup>4</sup> de Terra,<sup>5</sup> von Koenigswald,<sup>6</sup> and Movius.<sup>7</sup> The faunas from Yenchingkou and Choukoutien have been placed in an interglacial period, as both indicate a warmer climate for China than exists there now. Pei<sup>8</sup> places Choukoutien in the very beginning of the Pleistocene, but Teilhard agrees that "it seems quite likely that, on the basis of the work

of de Terra and Patterson in North India (1939), Cycle II (Sanmen) corresponds roughly to the second Himalayan glaciation."<sup>9</sup> As for Java, there is no actual evidence of climatic changes; therefore, the Trinil horizon is regarded as representing the second glaciation and very probably as part of the subsequent interglacial period.

*Bibos geron* has been listed from Choukoutien by Zdansky<sup>10</sup> on the basis of very incomplete material. But Young has revised this determination and shown that the remains belong to a water buffalo, *Bubalus teilhardi*.<sup>11</sup>

The association of the fossils found in Hoshantung demonstrates that the *Ailuropoda-Stegodon* fauna comprises a single unit. Nevertheless, the fauna includes various elements that may possibly indicate a period of climatic instability. Some of the forms, on the one hand, must be regarded as tropical or subtropical species: *Stegodon*, *Tapirus*, *Bibos*, the gibbons, and *Pongo*. *Paguma larvata*, the palm civet cat from Tanyang now living in the coastal provinces of central China, belongs to the same group. On the other hand, other forms might suggest a colder climate, especially since the living representatives are restricted to the high mountains of western China and the Himalayas. Among such forms is *Capricornis sumatraensis* (the serow), first reported by Chang<sup>12</sup> as *Tragocervus cf. kokeni* from Kwangsi, which is represented in my collection by a series of teeth and, according to a communication from E. H. Colbert, also occurs in Yenchingkou. It is impossible to determine whether or not *Nemorhaedus* sp. mentioned by Young<sup>13</sup> from this lo-

<sup>1</sup> Pei, 1939, 5.

<sup>2</sup> Teilhard, 1941, 43.

<sup>3</sup> Colbert, 1943, 426.

<sup>4</sup> Teilhard, 1941.

<sup>5</sup> De Terra, H., 1940, 113.

<sup>6</sup> Von Koenigswald, 1940, 74.

<sup>7</sup> Movius, 1944, 108; 1948, 347.

<sup>8</sup> Pei, 1939, 17.

<sup>9</sup> Teilhard de Chardin, 1941, 43.

<sup>10</sup> Zdansky, 1928.

<sup>11</sup> Young, 1932b, 78.

<sup>12</sup> Chang, 1934.

<sup>13</sup> Young, 1939, 321.

cality is the same form, since he gives neither definite description nor measurements. This name (also written *Naemorhedus*) was formerly used for the serow, but it is applied to the goral, another inhabitant of the high mountains. The fossil giant panda is so similar to the living form that it may have lived under the same conditions. The small panda, *Ailuropoda fulgens*, from Hoshantung, appears to be identical with the living species, restricted to regions above 12,000 feet in altitude.

The meaning of this faunal "mixture" is not yet clear. The occurrence of orang, now confined to the tropics, and *Ailuropoda*, now living in the high mountain region of Szechwan, in the same layer has been established by excavations. It seems quite improbable that one of these animals should have completely changed its living habits since that period. We are therefore forced to the conclusion that the deposits in these caves and fissures were laid down mainly during a period of climatic disturbances and changes, such as the beginning of a glacial period. The most probable time would seem to be the second glaciation (which is more pronounced than either the first or the third), a conclusion not only in accordance with the general character of the fossil fauna as a whole, but also with the presence of a representative of early man, closely related to the classical *Sinanthropus*.

Human teeth and jaws can also be found in Chinese drugstores. However, as man does not select a particular geological layer to bury his dead, we must exercise great care in deciding whether or not such human remains are actually fossil.

The first human tooth obtained in a Chinese drugstore was described by Schlosser in 1903.<sup>1</sup> It is by no means certain that this first tooth is actually a fossil, nor is it certain that it came from the vicinity of Peking. I have visited drugstores in that city where I have seen *Stegodon* material which very probably came from Yenchingkou and *Hipparion* teeth which may have come from Yunnan or Shansi. The isolated tooth from the Haber Collection is a third upper molar. According to Weidenreich its dimensions are surpassed by all but one of the eight third upper molars of *Sinanthropus*,<sup>2</sup> and it has a much simpler crown pattern than

the other third upper molars. According to Teilhard de Chardin, who has examined the original material, similar teeth in my collection may have come from the Mesolithic top layer that often occurs in the caves of South China.

Chang<sup>3</sup> has described as the jaw of a "primate" a fragment of a human lower jaw, found in a cave near Kwei-lin, Kwangsi, which came perhaps from a recent burial. It has small teeth, of which only the sockets have been preserved, and seems to belong to modern man. Fromaget and Saurin<sup>4</sup> described fragments of a human skull and some teeth, found with orang, in Indo-China. Neither the description nor the illustrations are, however, clear enough to permit a closer definition of this form which has been compared with *Sinanthropus*.

Traces of human activity have been observed in several of the caves, especially those in Kwangsi and Kwantung. In describing the fossil mammals from the Kwangsi caves, Pei<sup>5</sup> emphasizes the curious abundance of pig teeth found in one small cave in association with much larger forms such as *Rhinoceros* and *Paludina* shells "outside of any possibility of natural trapping and any evidence of flood." Bien and Chia<sup>6</sup> mention the occurrence of charcoal in the cave deposits of Yunnan. Weidenreich has compiled all the evidence bearing on human activity.<sup>7</sup>

Although most of the human teeth in my drugstore collection are probably from the Mesolithic layer, or may even be recent, a small number that display precisely the same state of preservation as the fossil teeth undoubtedly belong to a fossil hominid, contemporaneous with the remainder of the fauna. In the first note dealing with Chinese drugstores as a source of fossil collections, I mentioned *Sinanthropus*-like human teeth. These teeth have not yet been described in detail, because I was not entirely satisfied with the material from a morphological point of view: molars of *Sinanthropus*, with a more complicated pattern than European teeth, are similar to modern teeth of Mongoloid races, often differing only slightly, especially when the teeth are worn. Prior to 1939 it was not possible to present

<sup>3</sup> Chang, 1934, 10, Pl. 3, Figs. 6-7.

<sup>4</sup> Fromaget and Saurin, 1936, 36.

<sup>5</sup> Pei, 1935, 424.

<sup>6</sup> Bien and Chia, 1938.

<sup>7</sup> Weidenreich, 1945b, 93.

<sup>1</sup> Schlosser, 1903.

<sup>2</sup> Weidenreich, 1937, 71.

TABLE 6  
MEASUREMENTS (IN MILLIMETERS) OF FIRST LOWER PREMOLARS

	<i>Sinanthropus officinalis</i>	<i>Sinanthropus pekinensis</i> <sup>a</sup>		Modern Man <sup>b</sup>		
		Minimum	Maximum	Minimum	Maximum	Average
Mesio-distal	10.0	7.9	9.8	6.0	8.0	6.9
Labio-lingual	10.6	9.1	10.7	7.0	8.0	7.7

<sup>a</sup> After Weidenreich, 1937, 44.

<sup>b</sup> Black, after de Jonge-Cohen, 1932, 328.

proof that these teeth actually belong to a *Sinanthropus*. In 1939, however, in a Hong Kong drugstore I found a third lower premolar, which is discussed below.

While the dimensions of the *Sinanthropus* molars fall within the range observed in modern man, this is not true of those of the third premolar. As is obvious from an examination of Table 6, the minimum length of the *Sinanthropus* premolar is only 0.1 mm. below the maximum of modern man, while the maxi-

conid is the only recognizable cusp. The single root is preserved to a length of 11 mm., with the lower end gnawed by porcupines. At the mesial side of the root a bifurcation is indicated by a deep furrow.

An upper first molar of this hominid is illustrated in Pl. 49f. It is a large tooth (Table 7), with a cusp pattern simpler than that of the *Sinanthropus* from Choukoutien. This tooth, like others from the same source, possesses a Carabelli's pit which is absent from all the

TABLE 7  
MEASUREMENTS (IN MILLIMETERS) OF FIRST UPPER MOLARS

	<i>Sinanthropus officinalis</i> , Type	<i>Sinanthropus pekinensis</i> <sup>a</sup>		Modern Man <sup>b</sup>		
		Minimum	Maximum	Minimum	Maximum	Average
Mesio-distal	12.8	10.0	13.1	8.0	12.8	10.7
Labio-lingual	13.7	11.7	13.7	9.2	14.5	11.8

<sup>a</sup> After Weidenreich, 1937, 64.

<sup>b</sup> After Black, 1902, and M. de Terra, 1905.

imum is 1.8 mm. higher. In breadth, *Sinanthropus* far exceeds modern man in minimum and maximum dimensions. The pattern of the third lower premolar bought in Hong Kong is very similar to that of *Sinanthropus* Specimen 85,<sup>1</sup> but its dimensions are larger. The primitiveness of this tooth is indicated by a cingulum on its anterior corner.

In outline the crown is triangular, with rounded corners. The protoconid is prominent; a ridge extending from its tip reaches the lingual side; a pit-like fovea lies in front of the trigonid. The talonid basin is short; at the distal and lingual side it is closed by a blunt cingulum. The tooth is quite worn; the proto-

seven known upper first molars of *Sinanthropus pekinensis*. As a matter of convenience, I distinguish the *Sinanthropus* under consideration from the classical species as ***Sinanthropus officinalis***, new species. I regard the right upper first molar illustrated in this paper and bought in Hong Kong in 1935 as the type specimen. Its pulp cavity still contains the "yellow earth" typical of the Pleistocene deposit. All the specimens under consideration are part of my personal collection, now in Utrecht.

The human teeth bought in the drugstores will form the subject of a separate publication. They are mentioned here, however, because they prove the presence of a hominid of the *Sinanthropus* group in the orang-*Ailuropoda* fauna. The occurrence of the *Sinanthropus* type

<sup>1</sup> Weidenreich, 1937, 44.

of man in those layers is completely in accord with the early Middle Pleistocene age of that fauna, a conclusion that has been reached on the basis of the analysis of the faunal association.

A few additional teeth that are not definitely classifiable with either orang or *Gigantopithecus*

probably indicate the presence of forms related to the Australopithecinae in our fauna. They are of large size, too large for *Sinanthropus*, with a very simple cusp pattern and too small for *Gigantopithecus*. These teeth have not yet been studied in detail.

# GIGANTOPITHECUS BLACKI VON KOENIGSWALD<sup>1</sup>

## DESCRIPTION OF THE MATERIAL

AS STATED ABOVE, the material consists of three lower and one upper molar representing four different individuals, coming from at least two different localities. All the molars certainly belong to the same species. Four additional teeth (two lower premolars, one upper incisor, and one upper canine) may tentatively be referred to *Gigantopithecus*.

Independent of all interpretations and under all circumstances, the name *Gigantopithecus* has priority according to the International Rules of Nomenclature. I regret the necessity of emphasizing this point, but I feel compelled to do so because Weinert refers to this fossil as *Gigantthropus* and for undisclosed reasons he discusses the "Riesenzähne aus Chansi,"<sup>2</sup> a designation which is also incorrect.

Our *Gigantopithecus* molars are numbered as follows:

Specimen 1: third right lower molar, Hong Kong, 1935

Specimen 2: third right lower molar, Hong Kong, 1935

Specimen 3: second right upper molar, Canton, 1935

Specimen 4: third left lower molar, Hong Kong, 1939

<sup>1</sup> *Gigantopithecus blacki* von Koenigswald, 1935, 874.

<sup>2</sup> Weinert, 1950, 124.

## LOWER DENTITION

### THIRD LOWER MOLARS

Plate 48a-j

The three third lower molars, all of exceptional size, range from 22.3 to 23.1 mm. in length. The largest lower molar of a fossil orang from southern China, also bought in a drugstore in Hong Kong, is 19.8 mm. long; for the recent form the reported maximum is 18.2 mm.<sup>3</sup> According to Remane,<sup>4</sup> the second molar of gorilla attains a length of 19.7 mm., the third molar 19.4 mm. Of the fossil *Indopithecus giganteus* (Pilgrim) from the Middle Pliocene of the Indian Siwaliks, the third (or second) molar measures 19.1 mm. The *Gigantopithecus* teeth are the largest of a higher primate yet recorded.

The trigonid is broader than the talonid. This characteristic seems to be most marked in the type specimen, but since the lower margin is damaged, we have no indication of its original condition. In this tooth the trigonid breadth is greater than in the other two specimens. These differences, however, are no greater than in some fossil orang teeth from China, where I found differences as large as 2.1 mm.

<sup>3</sup> De Terra, M., 1905, 260.

<sup>4</sup> Remane, 1950.

## PLATE 48

### LOWER DENTITION

a-d. *Gigantopithecus blacki* von Koenigswald. Left lower third molar, Specimen 4, Hong Kong, 1939. a. Occlusal view. b. Mesial view. c. Buccal view. d. Skiagram from the buccal side.

e-g. *Gigantopithecus blacki* von Koenigswald. Right lower third molar, Specimen 1 (type specimen), Hong Kong, 1935. e. Occlusal view. f. Mesial view. g. Lingual view.

h-j. *Gigantopithecus blacki* von Koenigswald. Right lower third molar, Specimen 2, Hong Kong, 1935. h. Occlusal view. i. Mesial view. j. Lingual view.

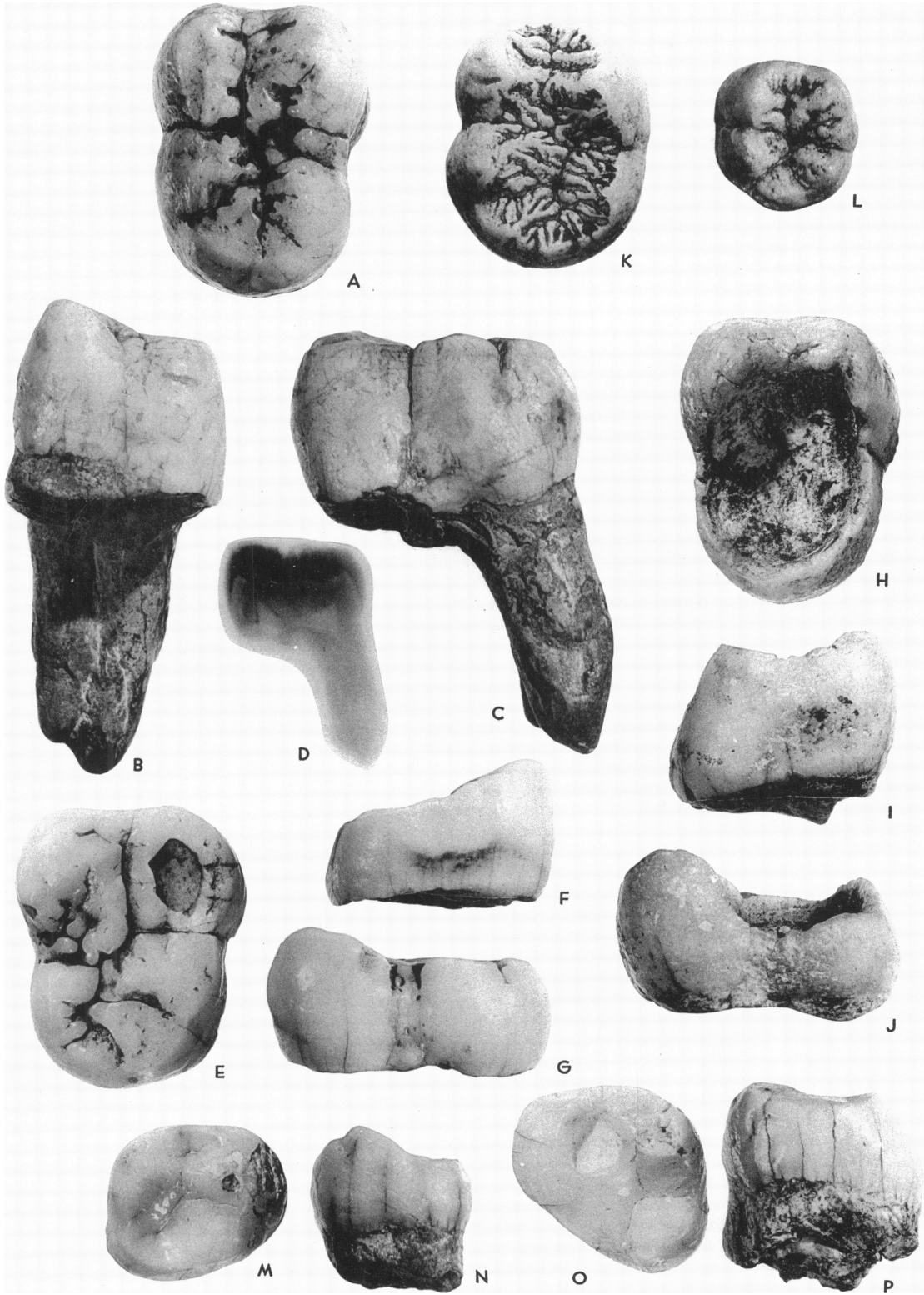
k. *Pongo* cf. *pygmaeus*, fossil orang. Left lower third molar, large specimen, Hong Kong. Occlusal view.

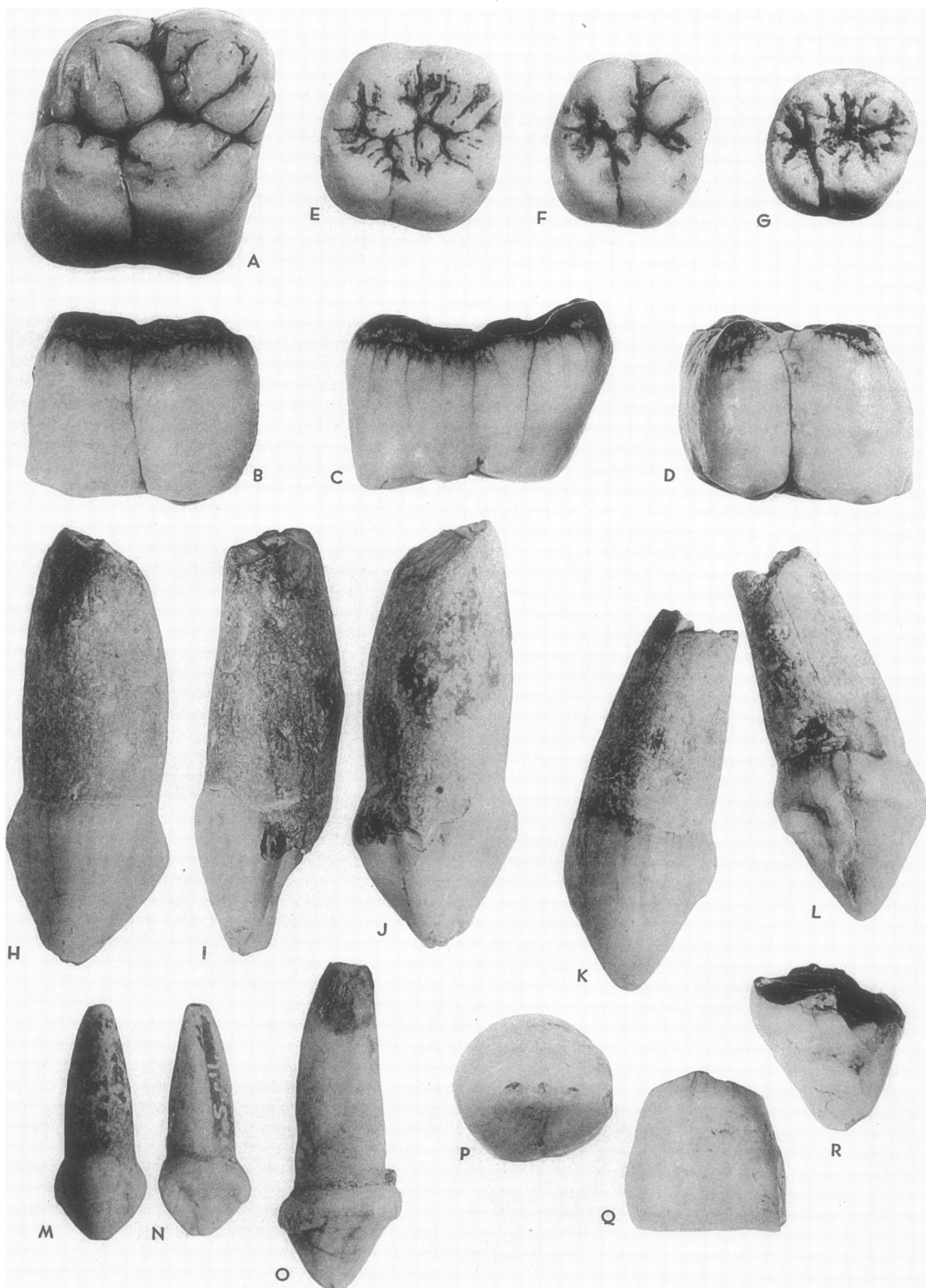
l. *Homo sapiens*, sub-Recent Javanese. Left lower molar, for comparison.

m-n. *Gigantopithecus blacki* von Koenigswald, referred specimen. Right lower last premolar, Hong Kong. m. Occlusal view. n. Buccal view.

o-p. *Gigantopithecus blacki* von Koenigswald, referred specimen. Left lower last premolar. o. Occlusal view. p. Mesial view.

All except l from Chinese drugstores; in the author's collection. d. Natural size. All others  $\times 2$ .







The teeth are both absolutely and relatively long, so the trigonid index is very low, ranging from 75.9 to 82.9. These, however, are not the lowest indices recorded. According to MacInnes,<sup>1</sup> these indices range from 74 to 85 for *Proconsul africanus*. The interesting point is that *Proconsul* is a very early and generalized form from the Lower Miocene of Kenya, East Africa, so a low index can be regarded as primitive. Other species with comparable indices are *Neopithecus brancoi* from the Lower Pliocene of Germany with an index of 76, and *Dryopithecus sivalensis* from the Lower Pliocene of India with an index of 78. For the living anthropoids, Gregory and Hellman<sup>2</sup> record 78.5 for the gorilla, 84.5 to 93.2 for the orang, and 86.9 to 98.2 for the chimpanzee.

The metaconid of Specimen 4 is 12.8 mm. high. The cusp is slightly worn; its original height may be estimated at about 14.0 mm., contrasting sharply with the orang teeth from the same layers. These teeth generally are not over 8 mm. high and are usually lower. For the high-crowned teeth of gorilla, Gregory and Hellman<sup>3</sup> report 8.5 mm. Our *Gigantopithecus* molar is not only absolutely but also relatively very high, giving the impression of a hypsodont tooth.

In addition to the usual five main cusps, the tooth pattern includes virtually all the second-

ary cusps that might possibly occur in the molar of a higher primate. The metaconid, the largest of the main cusps, is in contact with the hypoconid and has the primitive "*Dryopithecus* pattern." The metaconid is separated from the protoconid by a distinct cleft.

In Specimen 4 the hypoconid and entoconid are of the same size, but in the type specimen the entoconid is much smaller. The latter condition can often be observed in orang and gorilla. On the labial side the hypoconid is marked by furrows which reach about halfway down on the anterior end; the posterior furrow is shorter. A hypoconulid of normal proportions is developed in Specimen 4. In the type specimen, this cusp is enlarged and almost penetrates into the region of the entoconid.

All three molars have secondary cusps in the form of a single small cusp in the middle of the anterior border. Such a cusp is often developed in man. Another cusp, situated between the protoconid and entoconid, Selenka's "tuberculum accessorium mediale internum," is quite high and pronounced in Specimen 4, where it is in a single cusp. In Specimen 1 this cusp is smaller, consisting of a larger and a very minute cusp. A small tubercle rises between entoconid and protoconid on the labial side of this cusp in Specimen 4. In the worn type specimen this cusp is united with the main wrinkle from the metaconid.

This extra cusp between the protoconid and entoconid can occur in almost any of the an-

## PLATE 49

### UPPER DENTITION

a-d. *Gigantopithecus blacki* von Koenigswald. Right upper second molar, Specimen 3, Canton, 1935. a. Occlusal view. b. Lingual view. c. Mesial view. d. Buccal view.

e. *Pongo* cf. *pygmaeus*, fossil orang. Right upper first or second molar, large specimen, Hong Kong. Occlusal view.

f. *Sinanthropus officinalis*, new species. Right upper first molar, type specimen, Hong Kong, 1935. Occlusal view.

g. *Homo sapiens*, sub-Recent Javanese. For comparison.

h-j. *Gigantopithecus blacki* von Koenigswald, referred specimen. Right upper canine, Bandung. h. Buccal view. i. Mesial view. j. Lingual view.

k-l. *Pongo* cf. *pygmaeus*, fossil orang, central Java. Left upper canine. k. Buccal view. l. Lingual view.

m-n. *Sinanthropus pekinensis*. Right upper deciduous canine, Middle Pleistocene, Choukoutien. m. Buccal view. n. Lingual view. Cast.

o. *Pongo pygmaeus*, recent orang. Deciduous upper canine, lingual view.

p-r. *Gigantopithecus blacki* von Koenigswald, referred specimen. Median upper incisor, Hong Kong. p. Occlusal view. q. Buccal view. r. Mesial view.

All, except g, k-l, m-o, from Chinese drugstores; with the exception of o, in the author's collection. All  $\times 2$ .

TABLE 8  
MEASUREMENTS (IN MILLIMETERS) OF THIRD LOWER MOLARS OF *Gigantopithecus blacki*

	Hong Kong, 1935, Type Specimen 1	Hong Kong, 1935 Specimen 2	Hong Kong, 1939 Specimen 4
Height	(11.2) <sup>a</sup>	(11.8)	(12.8)
Length	22.3	23.1	22.4
Breadth	18.5	17.5	17.3
Length-breadth index	82.9	75.9	77.4
Trigonid breadth	18.5	17.5	17.3
Talonid breadth	(15.8)	15.4	15.7
Trigonid index	82.9	75.9	77.4

<sup>a</sup> Estimated measurements and indices are enclosed in parentheses.

thropoids. It is very typical in *Dryopithecus*, where it occurs in *D. punjabicus*, *rhenanus*, and *darwini*. Among living anthropoids, this cusp is found in every species, though most frequently in the gorilla, where, according to Remane,<sup>1</sup> it occurs in 35 per cent of all cases. Its highest development, however, is in modern man, where it attains the size of a main cusp. A distinctive type of human molar with six cusps results from an overdevelopment of this extra cusp. I found several examples among Malayan teeth from Java. According to De Terra,<sup>2</sup> the intermediate cusp is present in 2.5 per cent of Europeans, but in 20 per cent of the Papuans.

Bennejeant<sup>3</sup> regards this intermediate tubercle of man and the higher primates as identical with the metastylid of the tarsioids.

A small tuberculum sextum lies between the entoconid and the hypoconulid. This cusp may occur in all anthropoids (and even in macaques) as well as in man. It is frequent among Malaysians, even in the third deciduous molar. In *Gigantopithecus* it is a small triangular cusp bordered by two furrows, the lingual one being more accentuated. In the type specimen this cusp is broader than in Specimen 4 because the enlarged hypoconulid disturbed the entoconid and caused the development of three additional very small cusps at the anterior end of the entoconid.

As may be judged from Specimen 4, the cusps are somewhat blunt and swollen at the base, leaving very little space for the interven-

ing furrows. Weidenreich has termed this the "block pattern." The fovea anterior is compressed into a narrow fissure, and the fovea posterior is entirely suppressed. The hypoconid is completely bordered by furrows that also extend to the exterior side, reaching a deeper level on the anterior side.

Owing to surface wear, the wrinkles cannot be studied in detail. On the protoconid there seem to be two main wrinkles that terminate abruptly at the median cleft. The main wrinkle in the metaconid has a sharp posterior extension which Weidenreich has called the "deflecting wrinkle." This wrinkle is very typical for man, both fossil and recent, and also occurs in the anthropoids. It is very well developed in the first molar of *Dryopithecus cautleyi* figured by Lewis,<sup>4</sup> but is absent in most of the other Indian specimens. It is generally better developed in man than in the anthropoids.

A "deflecting wrinkle" is exceptionally well developed in some modern human deciduous molars from Java. This wrinkle is very probably part of the original trigonid crest to which the anterior part of the crista obliqua remained attached, but lost its function when the hypoconid became directly connected to the protoconid. If this interpretation is correct, the "deflecting wrinkle" must be regarded as a very primitive character.

Both the hypoconid and the entoconid in Specimen 4 show traces of three main wrinkles. The central fovea is very steep. When viewed from behind, the border of the enamel slopes down from the labial to the buccal side. Ob-

<sup>1</sup> Remane, 1921.

<sup>2</sup> De Terra, M., 1905.

<sup>3</sup> Bennejeant, 1936, 134, Fig. 117.

<sup>4</sup> Lewis, 1934, Pl. 2, Fig. 2.

TABLE 9  
MEASUREMENTS (IN MILLIMETERS) OF SECOND LOWER PREMOLARS (P<sub>4</sub>)

	Cf. <i>Gigantopithecus</i>		Orang, Range	Gorilla, <sup>a</sup> Range
	Left	Right		
Mesio-distal	15.9	12.5	12.4- 9.5	13.5-11.0
Labio-lingual	15.5	14.2	13.2-10.4	15.4-12.5

<sup>a</sup> After Gregory and Hellman, 1926.

served from the anterior end, the wear of the tooth is greater on the buccal than on the labial side (Pl. 48a-d).

In Specimen 2 it is apparent that the metaconid itself is not very much affected by wear. Nevertheless, virtually its entire surface is worn off, and the enamel is higher than the dentine of the tooth surface. These conditions do not occur in any of the numerous orang teeth from the same layer.

The posterior root, preserved in Specimen 4 and damaged on the lower end, is nearly 26 mm. long. The root has a marked furrow on the inner side.

As is clearly visible in the skiagram (Pl. 48d), the pulp cavity of this tooth is low and depressed. In the orang, as in the chimpanzee, this cavity can be either high or low.<sup>1</sup> In early man the pulp cavity is generally high ("Taurondent"-Heidelberg Man, *Sinanthropus*, Neanderthal Man), so that in this respect *Gigantopithecus* bears no resemblance to the early hominids.

#### SECOND LOWER PREMOLARS

##### Plate 48m-p

The crowns of two lower last premolars (P<sub>4</sub>) in the collection, a right and a left one, differ from those of orang in having a simpler pattern. Because of their large size they might be referred to *Gigantopithecus*. Both teeth are from Hong Kong drugstores.

Although differing in outline from each other, the two teeth have common features in the position of the protoconid, which is shifted somewhat towards the inner side, causing not only the buccal slope to be less steep than in orang, but the separation of the metaconid from the mesial cingulum at the lingual slope.

The right lower premolar (Pl. 48m-n) is bluish in color. Part of the enamel has been

destroyed on the buccal side, but where it remains, it shows some fine wrinkles that are less developed than in orang. The fovea anterior is well developed, and the trigonid crest is bisected by a transverse fissure. The trigonid basin is short and only slightly differentiated. The greatest length is 12.5 mm.; the breadth, 14.2 mm.

The left lower premolar (Pl. 48o-p) is more triangular in outline than the right, and yellow in color. The anterior fovea is compressed and partially obliterated by wear, which has leveled the greater part of its surface. At the distal and mesial slope of the metaconid there are fine wrinkles. A large cusp in the disto-lingual corner of the talonid is flattened by wear and has a small triangular groove that may be a remnant of a posterior fovea, indicating therefore a high degree of molarization.

Remane has described considerable variability in the premolars of recent anthropoids. The premolars under consideration do not differ from each other any more than do the premolars of the living gorilla.<sup>2</sup> Naturally this does not prove that they belong to the same species, nor are we now able to prove that any of the four teeth tentatively referred to *Gigantopithecus* really belong to that genus. The subject is quite complicated as, in addition to orang, the fauna includes other higher anthropoids that have not yet been described. These cannot be assigned to their respective species until all the material has been carefully studied, a task which cannot be undertaken until some future date. Therefore, any conclusion we are able to draw about the position of *Gigantopithecus* must be based entirely upon the four molars.

Both premolars surpass those of the living orang in every dimension; the left premolar is even larger than that of the gorilla. The last pre-

<sup>1</sup> Weidenreich, 1937, Figs. 320-321.

<sup>2</sup> Remane, 1921, 51, Fig. 9.

molar of our Chinese orang is in the main relatively longer, showing a tendency towards molarization; however, short specimens also occur. As already stated, there is a considerable variability in this tooth, so that no positive conclusions can be drawn from these two specimens.

## UPPER DENTITION

### SECOND UPPER MOLAR

#### Plate 49a-d

The upper molar, Specimen 3, is from the right side and, since it has contact facets on both sides, must be either a first or second molar. Its large size and its slightly rhomboid outline, together with the fact that in the external view the metacone is smaller than the paracone, seem to indicate that it is a second molar. In anthropoids and early humans the second molar is larger than the first; first molars generally have a more quadratic outline. Also, in first molars the metacone and the paracone are usually equal in size. For these reasons the tooth should be regarded as a right upper second molar.

Only the crown is preserved; the roots are missing. The large pulp cavity is open, and part of it still contains the original matrix, a reddish filling containing small grains of iron ore, like that which often occurs in fissure deposits in limestone regions. The absence of the roots and the bluish color of the fossil present exact parallels to the conditions found in other teeth from the drugstores. The tooth, which has the high, blunt, swollen cusps so characteristic of the lower molars just described, undoubtedly belongs with them.

Like the lower molars, the upper molar is of exceptional size; its length and breadth exceed these dimensions in all known higher primates. The crown is very high; its height at the slightly

worn paracone is 14.5 mm.; its original height was at least 15.0 mm. This specimen, which approaches the molar of the gorilla in length, can readily be distinguished by the very different form of its cusps. In the gorilla the cusps are divided at the base, are high and pointed, and the crown pattern is quite different from that of the tooth in question.

The general impression derived from an examination of the molar is that of a solid block into which the pattern has been carved rather superficially. When viewed from the buccal sides, the cusps appear to be barely separated below the surface. Between the paracone and the metacone there is a small furrow of 2 mm. (Pl. 49d) and a cleft of the same dimensions between the hypocone and the protocone (Pl. 49b). Vertical cracks in the prolongation of both these features indicate the old lines of fusion. Another small indentation below the surface is visible in the middle of the distal side (Pl. 49c). Except for these four morphologically unimportant features, no other details are visible on the surface.

The crown consists of five cusps: four large ones, the ordinary main cusps; the fifth, a smaller cusp, is located between the paracone and the protocone. Although this intervening cusp is a secondary element, its height approaches the level of the main cusps. The internal slopes of the main cusps bulge in such a way that they rise to a nearly horizontal position. All the main cusps resemble blocks and are sharply separated by deep, narrow furrows (Pl. 49a) that produce only superficial incisions at the outer margin. As is usual, the protocone is the largest cusp; the metacone, next in size, is about equal to the hypocone. The space for the paracone is restricted by the secondary cusp which is triangular in outline and reaches the mesial edge.

TABLE 10  
MEASUREMENTS (IN MILLIMETERS) OF SECOND UPPER MOLARS

	<i>Gigantopithecus</i> Specimen 3	Gorilla <sup>a</sup> Maximum	Orang <sup>a</sup> Maximum	Recent Man <sup>b</sup>	
				Maximum	Average
Length	18.7	18.6	14.8	10.0	9.2
Breadth	27.3	19.6	17.7	12.5	11.5

<sup>a</sup> After Remane, 1921.

<sup>b</sup> After Black, 1902.

This secondary cusp is of particular interest as it is the only additional element to the traditional main cusps. Its position is the same as that of the secondary wrinkle generally developed in orang, forming the buccal half of the posterior wall bordering the anterior fovea (Pl. 49e). In orang this element usually reaches the bucco-lingual corner. In modern human teeth from Java, I have frequently observed a secondary cusp between the paracone and protocone (Pl. 49g) which tends to extend in the mesio-distal direction and sometimes reaches the mesial edge of the tooth.

The cusps are slightly worn. The presence of furrows indicates that they were originally covered by coarse wrinkles. The marginal edges of the paracone and metacone are turned into "sheets" (Pl. 49a), forming a kind of wall, which is only slightly interrupted, between the two cusps (Pl. 49d). Two main folds are indicated at the metacone. The distal edge shows a superficial interruption between the metacone and hypocone, and two short folds are indicated at the latter. The fovea posterior is short and narrow, subdivided by a transverse furrow. Two folds originate at the protocone, one facing the metacone, the other the secondary cusps. The area in which the fovea anterior is normally situated is virtually filled by that cusp. A furrow that separates the mesial edge extends obliquely in the direction of the center of the protocone and can be traced for a short distance on that cusp. This furrow, which in its buccal section may represent part of the original fovea anterior, is bisected by the pronounced furrow that separates the additional protoconule and cuts through the mesial wall (Pl. 49c).

The large additional cusp, which we have called a secondary cusp, is regarded by Weidenreich apparently as a derivative of the paracone; in the description he used the term "flower-bud pattern of paracone." A closer comparison with the dentition of lower primates has led me to the conclusion that this particular cusp is nothing but an exaggerated protoconule that we find persisting in several of the higher primates including man.

#### MEDIAN UPPER INCISOR

Plate 49p-r

A fragment of a right upper incisor was bought in Hong Kong. The tooth differs considerably from that of orang and may possibly

belong to *Gigantopithecus*. Only the upper part of the crown is preserved. There are two contact facets, the larger one at the mesial and the smaller one at the distal side, proving that we are dealing with a central incisor. The cutting edge, barely worn, shows that three mamme-  
lons were once present.

The mesio-distal diameter, the only reliable measurement, is 12.7 mm. In comparison, the bucco-lingual diameter is greater, and evidently it originally exceeded the breadth. The buccal and lingual slopes of the tooth form an angle of about 45 degrees (Pl. 49p-r). A shallow central fossa on the lingual surface is bordered by a broad rim. The basal part of the rim is so badly damaged that the original height cannot be estimated.

I would not mention this fragment were it not that in certain features the tooth resembles the same incisor in *Pithecanthropus modjokertensis* where the bucco-lingual diameter exceeds the mesio-distal one. A thickening of the rim at the lingual surface of the tooth under consideration would produce exactly the same type of shovel-shaped incisor as that observed in *Pithecanthropus*.

At this time it is not possible to decide whether or not the incisor would prove too small to be included with a form as large as *Gigantopithecus*.

#### UPPER CANINE

Plate 49h-j

Among the upper canines, virtually the entire root of one, bought in Bandung, is preserved. This tooth differs from canines undoubtedly belonging to orang not so much in the shape and size of the relatively small crown but rather in the size and position of its root. With the necessary reservations, it might be referred to *Gigantopithecus*.

The tooth is a moderately worn right upper canine. The crown is complete, except for the anterior section of the internal cingulum, where part of the enamel is chipped. At the buccal side the crown has a maximal mesio-distal diameter of 13.1 mm.; at the neck, the diameter is 11.1 mm. Its height is now 13.5 mm., but the tip is worn. The bucco-lingual diameter can be estimated at 11.0 mm. The cingulum, which is damaged, is visible only at the lingual surface, which has a flat median vertical ridge, bordered

by a furrow, at its mesial side. The tip has a central position.

The root is thick, oval in cross-section, and except for its apex is fully preserved. As can be observed in the cross-section, the root canal is not centrally located but is shifted towards the distal side. The present length of the root is 21.5 mm., but originally it was at least 25.0 mm. long; its largest diameters are: mesio-distally, 11.8 mm.; labio-lingually, 10.5 mm.

While the root in all anthropoids is curved backward, tapering towards the end (because of the pronounced prognathism), in this tooth the axis of the crown and the axis of the root form a single straight line. The anthropoid conditions can be observed in the illustration (Pl. 49k-l) of the left upper canine of a female fossil orang, with approximately the same dimensions as the canine from China. Only in man do we find a parallel to the straight root in the canine under consideration.

In anthropoids a straight root occurs only in the deciduous canines, for which orang might serve as an example (Pl. 49o). A better example for comparison can be found in the deciduous canine of *Sinanthropus* which has not yet been described. Professor Weidenreich was kind enough to give me a cast (Pl. 49m-n) of this canine.

Comparing the *Sinanthropus* canine with the tooth from Bandung, we find that the crown has not only the same kind of neck but the same relation between breadth and height and the same type of cingulum. In fact it is a miniature edition of the canine bought in the drugstore. That the latter is not a deciduous tooth is indicated by the massive root and small root canal.

We might conclude that this canine belongs to a large primate which has relatively small canines and is less prognathous than the known anthropoids. For that reason there is a possibility that we are dealing with a canine of *Gigantopithecus*.

## CHARACTER OF THE *GIGANTOPITHECUS* MOLARS

THE MOLARS of *Gigantopithecus* are large, with high, blunt cusps separated by deep, narrow furrows. The internal slopes of the cusps bulge, filling the intervening valleys to an almost horizontal level, and giving the teeth the appearance of solid blocks in which the cusps have been superficially carved. There are a few coarse, well-defined wrinkles, especially in the lower molars. The lower molars possess the *Dryopithecus* pattern, have a well-developed tuberculum sextum and a well-defined accessory cusp between the metaconid and entoconid. In the upper molar the hypocone is large; an accessory cusp between the protocone and the paracone almost fills the space that is normally occupied by the fovea anterior.

As Weidenreich<sup>1</sup> has already discussed the affinities of the *Gigantopithecus* teeth in great detail, only a few additional comments are now necessary.

The *Gigantopithecus* molars surpass all known human and anthropoid teeth in size. Only two forms approach them in size: gorilla and *Indopithecus giganteus* from the Middle Pliocene. In gorilla the length of the third lower molar attains a maximum of 19.4 mm. The cusps are high, widely separated, and have few or no wrinkles. In *Indopithecus giganteus*, a form of unknown relationship (which we have excluded from *Dryopithecus*, *sensu stricto*, a view also held by Remane), the isolated third (or second) lower molar is 19.1 mm. long. It has pointed cusps and traces of a finer and less developed wrinkle system than is observable in the *Gigantopithecus* molars. In addition, it is only 8.5 mm. high in contrast to *Gigantopithecus* which was approximately 13.5 mm. high. We refer to *Indopithecus* below.

The difference between the orang and the chimpanzee is marked. In the former the molar cusps are low; in the latter they are high. Each has developed a characteristic wrinkle pattern; in the chimpanzee the wrinkles are fine and numerous; in the orang they are more numerous, but less regular. Identical with, or closely related to, the latter is the fossil orang of China, which occurs in the same layers as *Gigantopithecus*. The differences are readily observable in the illustrations of an upper and

lower molar (Pls. 48k, 49e) clearly showing that *Gigantopithecus* is not an orang, as has been suggested by some authors.

Not in any of the fossil anthropoids, nor in the Australopithecinae, do we find either the "block pattern" of the molar cusps or the development of the same kind of wrinkle system. In the Australopithecinae, the teeth are lower, the cusps less separated, and the third lower molars, which show a partial destruction of the original "*Dryopithecus* pattern" by secondary cusps, are more highly specialized.

The dentition of modern man repeats the pattern of the *Gigantopithecus* molars, even in minor details, to an astonishing degree. In the upper molar (Pl. 49g) we observe relatively low cusps from which a few coarse, well-developed wrinkles originate. The fovea posterior is limited. The anterior fossa is completely destroyed. An extra cusp lies between the paracone and protocone; in some cases it extends in the mesiodistal direction and is in contact with the mesial border.

In the lower molars of man (Pl. 48l) the same additional elements, such as the "tuberculum accessorium mediale internum" and the tuberculum sextum, may be present. Most obvious of all is the development of the "deflecting wrinkle" (Weidenreich) which, beginning at the tip of the metacone, extends in the direction of the tip of the protocone until it reaches the fissure separating both cusps; it then turns and continues in a distal direction for a short distance, terminating at the main furrow which separates the metaconid from the entoconid. This wrinkle, only traces of which are found in the anthropoids, where markedly developed, is typical for man, *Sinanthropus*, *Pithecanthropus modjokertensis*, and *Gigantopithecus*.

The flat type of wear of the *Gigantopithecus* molars suggests the kind of attrition found in man. In the oblique position of the chewing surface, sloping downward from the lingual to the buccal side (Pl. 48f), the specimen under consideration shows the same incline as observed in Neanderthal man of La Quina.<sup>2</sup>

The great height of the molar suggests a large and wide pulp cavity. It is surprising,

<sup>2</sup> Martin, 1923, 184, Fig. 31.

<sup>1</sup> Weidenreich, 1945b.

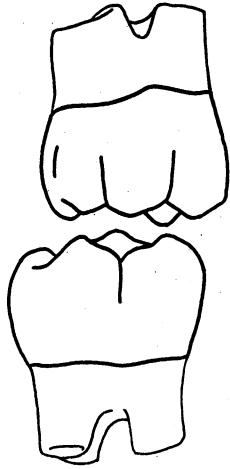


FIG. 1. First upper and lower molar of modern man, twice natural size (after Selenka).

therefore, that the skiagram reveals a shallow one (Pl. 48d) and no inclination towards the taurodontism so typical of *Sinanthropus* and Neanderthal Man.

In addition to all these factors, *Gigantopithecus* closely parallels man in another im-

portant point, that is, in the tendency towards hypsodontism. If we take the breadth-height index (the length-height index is difficult to use because of the extreme length of the *Gigantopithecus* molars) we find, according to Weidenreich<sup>1</sup> that for chimpanzee it is 58.8; for gorilla, 54.3; for orang, 41.3; and for modern man, 61.2. For *Pithecanthropus* and *Sinanthropus* the index is about 55, while it attains its maximum in *Gigantopithecus* with 73.6.

It is precisely this pronounced tendency towards hypsodonty that produces the human appearance in the *Gigantopithecus* molars. In all anthropoids, both recent and fossil, the crowns of the molars are relatively low. The enlarged teeth of modern man (Fig. 1) can quite easily be mistaken for *Gigantopithecus* molars. The general pattern of the wrinkles also shows an astonishing resemblance to the condition in man. The combination of these two facts seems to warrant placing *Gigantopithecus* in the hominid rather than in the anthropoid group of the Hominidae.

<sup>1</sup> Weidenreich, 1945b.



## THE POSITION OF *GIGANTOPITHECUS*

As SHOWN ABOVE, a series of observations indicates that *Gigantopithecus* is a member of the hominid group. What, then, is his position within this group and his relationship to modern man? Let us first attempt a morphological analysis. In the lower molars, the great relative length, the undisturbed "*Dryopithecus* pattern," and the occurrence of a tuberculum sextum should be regarded as primitive. The small tuberculum between the metaconid and the entoconid is present in many fossil anthropoids, such as *Proconsul africanus*, *Dryopithecus darwini*, *Dryopithecus germanicus*, *Indopithecus giganteus*, and *Sivapithecus indicus*. Even if this tuberculum is not a true primitive element, it is inherited from an old ancestral form. Among the hominids possessing this cusp are *Meganthropus*, *Pithecanthropus*, *Sinanthropus*, Neanderthal Man (Le Moustier, Krapina, Tanbach); it also occurs regularly in modern man. De Terra<sup>1</sup> found it to be present in the third lower molars in 2.55 per cent of Europeans, in 8 per cent of Chinese, and in 20 per cent of Papuans. The presence of two widely separated roots is also a primitive character.

The first evidence of specialization to be noted is the great relative height of the lower molar, with a breadth-height index of 73.6, which is higher than that of any other anthropoid or hominid. Second, we should note the peculiar shape of the cusps, the internal slopes of which virtually fill the intervening valleys, producing a nearly flat surface cut by steep and narrow fissures. These characteristics distinguish these teeth from all others, of either anthropoids or man.

The description of the shape of the cusps and height of the crown of the lower molar applies also to the upper molar. Here we find no primitive traces except, perhaps, the large size of the hypocone. The evidence favoring specialization is, however, much clearer in the upper molar. The major points can be categorized as follows: first, the tendency towards the suppression of the furrow that separates the paracone and metacone at the buccal surface and the hypocone and protocone at the lingual surface; second, the overdevelopment of the marginal edges of the paracone and metacone, eliminating the

bulge of the buccal surface (generally present in man) and transforming it into a flat, perpendicular wall; third, the destruction of the fovea anterior, still present in *Meganthropus* and *Pithecanthropus*, and the inflation of a secondary element in the corner between the paracone and the protocone. The "crista obliqua" between the protocone and the metacone, still developed in about 50 per cent of the Europeans, is absent; where normally there should be a crest or crest-like formation, often divided by a fine, narrow furrow, swollen main cusps face each other, separated by a deep, narrow furrow. Fourth, the complete absence of any trace of the cingulum in the upper (and lower) molar is also a specialized condition. Furthermore, we should note the peculiar shape of the lingual slope of this molar. In man this is a bulging slope; in *Gigantopithecus* it is flat (Pl. 49c). This, too, is a very unusual condition.

For the reasons just presented, *Gigantopithecus* must be regarded as a highly specialized form, with molars more specialized than those of modern man, which they resemble in pattern but surpass in degree of hypsodontism. We should remember that the breadth-height index (which in *Gigantopithecus* can be calculated only for the lower molar) is 73.6, while in *Sinanthropus* and *Pithecanthropus* it is only about 55, and in modern man 61.2. The breadth-height index of *Gigantopithecus* approaches that in modern man more closely than that in early man.

As we have noted, side by side with *Gigantopithecus* there already existed a member of the *Sinanthropus* group, *Sinanthropus officinalis*. Even if it could be proved that *Gigantopithecus* is a member of the Hominidae, he cannot be considered one of the forerunners of modern man.

The results of morphological analysis are completely confirmed by the geological evidence. As we have already seen, the age of the *Ailuropoda*-orang fauna, of which *Gigantopithecus* is a member, can be determined as (early) Middle Pleistocene, the Lower Pleistocene being the Villafranchian, in China represented by Teilhard's Sanmenian.

In Fig. 2 is presented a reconstruction of the jaw to give some idea of its probable size. Although highly hypothetical, it may help to

<sup>1</sup> De Terra, M., 1905.

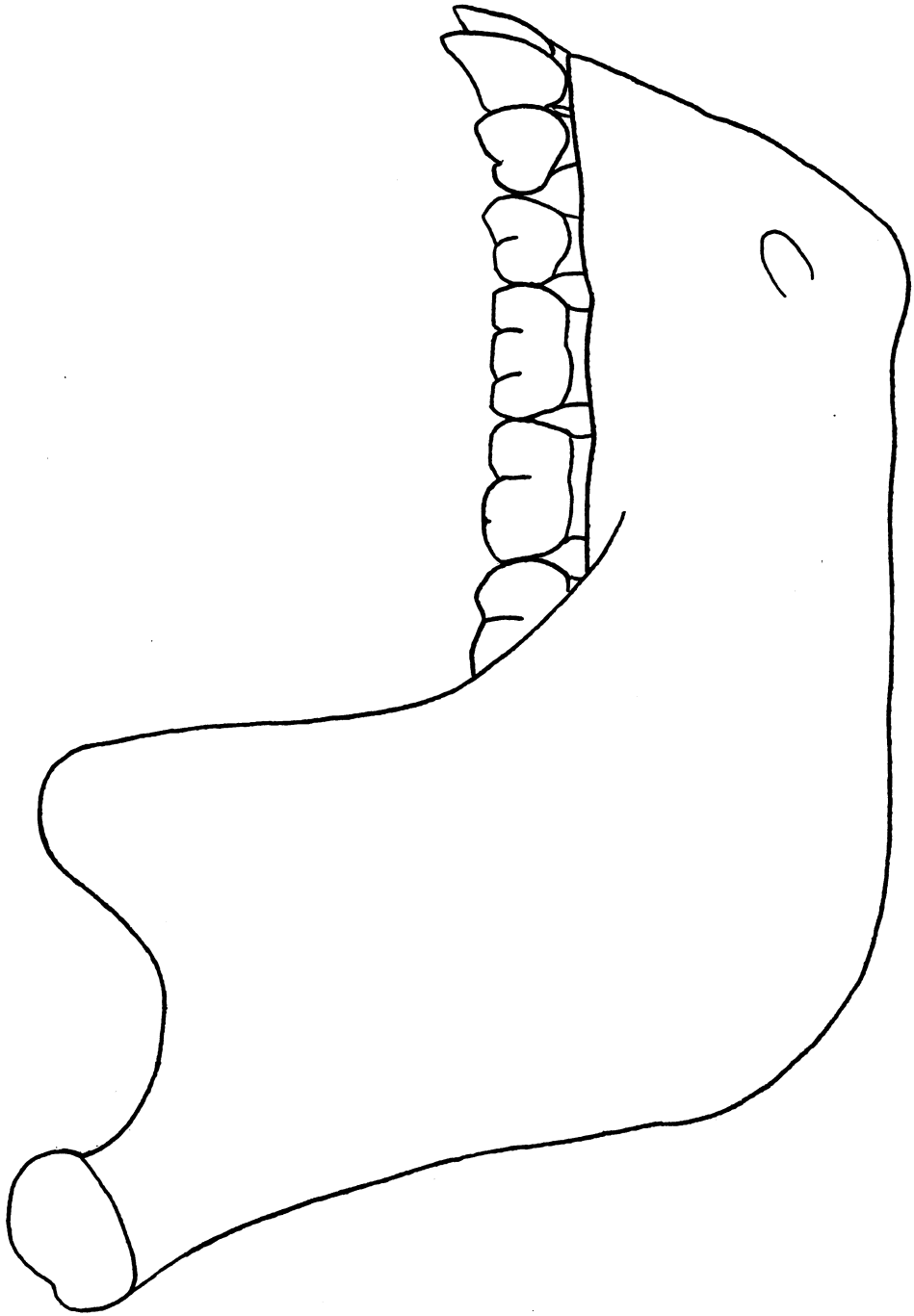


FIG. 2. Reconstruction of the lower jaw of *Gigantopithecus blacki* von Koenigswald, natural size.

visualize the gigantic size of this interesting form.

The four teeth, tentatively referred to *Gigantopithecus*, do not give many clues to its phylogenetic position. The most interesting specimen is the upper canine, which, because it has a straight root, suggests a form much less prognathous than in any of the living anthropoids, and perhaps a human type of face.

*Gigantopithecus* probably was the latest survivor of an Asiatic stock which more or less parallels the human line. Very little can be said as to his ancestry, but probably there is a relation to *Indopithecus giganteus* (Pilgrim) from the Middle Pleistocene of the Indian Siwaliks. This form was formerly regarded as a *Dryopithecus*. I<sup>1</sup> have tried to demonstrate that the large lower molar from Alipur (the type specimen) and the first lower premolar from Haritalyanger, formerly referred to *Sivapithecus* cf. *indicus*, both belong to the same type of animal. This premolar, shortened in mesio-distal direction, to some degree approaches the conditions found in man. The lower molar, which is quite low, with a breadth-height index of 52.8, is not overspecialized and could easily be transformed into the high-crowned molar type of *Gigantopithecus*. As *Indopithecus* is of Middle Pliocene, and *Gigantopithecus* of Middle Pleistocene, age, there is enough time for such a specialization.

While the type specimen of *Gigantopithecus*, the worn lower molar, was described in 1935, this is the first description of the additional original material. There is, however, an extensive literature concerned with *Gigantopithecus*. During the war, in 1945, Weidenreich published a detailed study, when communication with me was impossible. He has also described the casts of Specimens 3 and 4 in other publications. He argued brilliantly, although with some reservation, in favor of the human nature of *Gigantopithecus*. He, however, underestimated the evidence favoring overspecialization. In judging this fossil from a purely morphological point of view, he endeavored to place *Gigantopithecus* in an earlier geological age than is justified by the evidence. As the fossil hominids from the lower Pleistocene of Java (*Meganthropus paleojavanicus* and *Pithecanthropus modjokertensis*) are large forms, he suggested still larger ancestors, and therefore placed *Giganto-*

*pithecus* in a central position as ancestral to the early Chinese and Javanese hominids as well. This, however, as we already have seen, is impossible, both on morphological and geological grounds. Weidenreich's conclusions, for the greater and most essential part, cannot be confirmed.

Weidenreich's conclusions have generally been accepted with reservation. Weinert, among those who follow Weidenreich, has published a reconstruction of the *Gigantopithecus* jaw.<sup>2</sup> His reconstruction, which is merely an enlarged Heidelberg jaw, is without doubt incorrect. The mandibles of the early Asiatic hominids, such as *Pithecanthropus* and *Sinanthropus*, have a rather narrow and high ramus, quite different from the broad and low ramus of Heidelberg Man. Weinert's suggestion that the two third lower molars (Specimens 1 and 4) must belong to the same individual<sup>3</sup> is without foundation.

Among those who regard *Gigantopithecus* as a giant anthropoid, we should mention Gates<sup>4</sup> and especially Remane.<sup>5</sup> The latter notes that the tendency towards hypsodontism is indeed a human characteristic, but he is influenced by the outline of the lower molar and certain details in the pattern of both the lower and upper molars, which, with his vast experience in the dentition of modern anthropoids, he regards as typically simian. Not without astonishment, I note (and this is also true of the publications of Weinert and Wüst) that Weidenreich's classical description of the dentition and mandibles of *Sinanthropus* is still unknown in Germany. The slight sinus at the labial side of the lower molar, caused by the greater breadth of the trigonid, which appears so suspicious to Remane, is also present in *Sinanthropus*,<sup>6</sup> as is the broad contact between the metaconid and hypoconid. That the fossa between hypocone and the trigon in the upper molar of man must be straight is also not correct. Similar conditions, like those in *Gigantopithecus* where this fossa forms a distinct angle, can be observed in *Pithecanthropus modjokertensis*, in Neanderthal Man (Krapina),<sup>7</sup> and even in modern man

<sup>2</sup> Weinert, 1948, 25.

<sup>3</sup> *Ibid.*, 1950, 127.

<sup>4</sup> Gates, 1948, 56.

<sup>5</sup> Remane, 1950.

<sup>6</sup> Weidenreich, 1937, Fig. 166.

<sup>7</sup> *Ibid.*, 1937, Fig. 123.

<sup>1</sup> Von Koenigswald, 1949.

(recent Javanese). Details will be presented in a future description of the *Pithecanthropus* dentition; the base from which Remane has judged our materials is inadequate.

Robert Broom, to whom I had sent a cast of the upper molar, compared this tooth with the upper molar of *Paranthropus* and believed the resemblance to be so close as to suggest that *Gigantopithecus* will prove to be a member of the Australopithecinae.<sup>1</sup> While he did not place *Gigantopithecus* with the Australopithecinae in his phylogenetic scheme (see his Fig. 8),<sup>2</sup> later he branched *Gigantopithecus* off directly from the *Australopithecus* group.<sup>3</sup>

These Australopithecinae form a very peculiar group of primates. In dentition, brain capacity, and pelvis they surely approach the hominids more closely than the anthropoids, and must in a broad sense be regarded as hominids. I have suggested that they may represent the extinct "animal line" of the hominids,<sup>4</sup> as separated from the group which by a (correlated) reduction of the dentition and the jaws and an expansion of the braincase became the "human line" leading to man. Certain signs of

overspecialization, such as the molarization of the first lower deciduous molar, make it very doubtful, as does the early geological age, that the Australopithecinae are really ancestral to man.

The Australopithecinae are as yet known only from South Africa. But as has already been stated, a few isolated teeth from China probably belong to an Asiatic member of this group. It is not possible that the Australopithecinae will prove to be of Asiatic origin.

While we must leave the final solution of these problems to the future, I believe that a parallel can be drawn, that *Gigantopithecus* as well as the Australopithecinae belong to overspecialized side branches of the human line of evolution. However, it seems very doubtful, nor can it be demonstrated, that *Gigantopithecus* can be placed within the group of the Australopithecinae, *sensu stricto*.

The *Gigantopithecus* material now available is very limited. I have tried to point out why I believe in the human relationship of this giant, and what I believe this relationship to be. We can only hope that additional and more complete finds in the not-too-distant future will permit us to establish the position of *Gigantopithecus* with certainty.

<sup>1</sup> Broom, 1941, 12.

<sup>2</sup> *Ibid.*

<sup>3</sup> Broom and Schepers, 1946, Fig. 23.

<sup>4</sup> Von Koenigswald, 1940, 180.

## SUMMARY

*Gigantopithecus blacki* VON KOENIGSWALD is known from four molars bought in Chinese drugstores in Hong Kong and Canton. These represent four individuals from at least two different localities. In addition four other teeth (two last lower premolars, one upper median incisor, and one upper canine) can tentatively be referred to the same species.

The molars are the largest known of any higher primate. In pattern they come close to man, but in the degree of hypsodontism they surpass even modern man. *Gigantopithecus* might be regarded, with reservation, as a gigantic member of the human group (the tend-

ency towards hypsodonty has not been observed in anthropoids), but as a certain degree of overspecialization is already observable in the molars, he cannot be regarded as ancestral to man.

The same conclusion is reached on the basis of geological observations. The *Ailuropoda*-orang fauna of southern China, of which *Gigantopithecus* is a member, belongs to the (early) Middle Pleistocene. Within this fauna there already existed a hominid of ordinary size, *Sinanthropus officinalis* von Koenigswald, a form contemporary with *Sinanthropus pekinensis* Black of North China.

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## ERRATA

- Page 102, Fig. 1: For Site 6 on the map the symbol should be a triangle over a circle, not a triangle over a solid dot.
- Page 124, Table 2, footnote *a*, and Table 3, footnote *a* should both read "Sites listed in chronological sequence, beginning with the earliest on the right."
- Page 137, Table 4, footnote *a* should read "Sites are listed in chronological sequence, beginning with the earliest at the right."
- Page 158, first column, line 13 from bottom, read "A. Northeastern Phase" for "A. Northeastern."
- Plate 10 (legend), second column, line 3 from bottom: Read "21.20-1822" for "17.20-1822."
- Plate 13 (legend), next to last line: Read "1-12" for "1-16."

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