INTRODUCTION

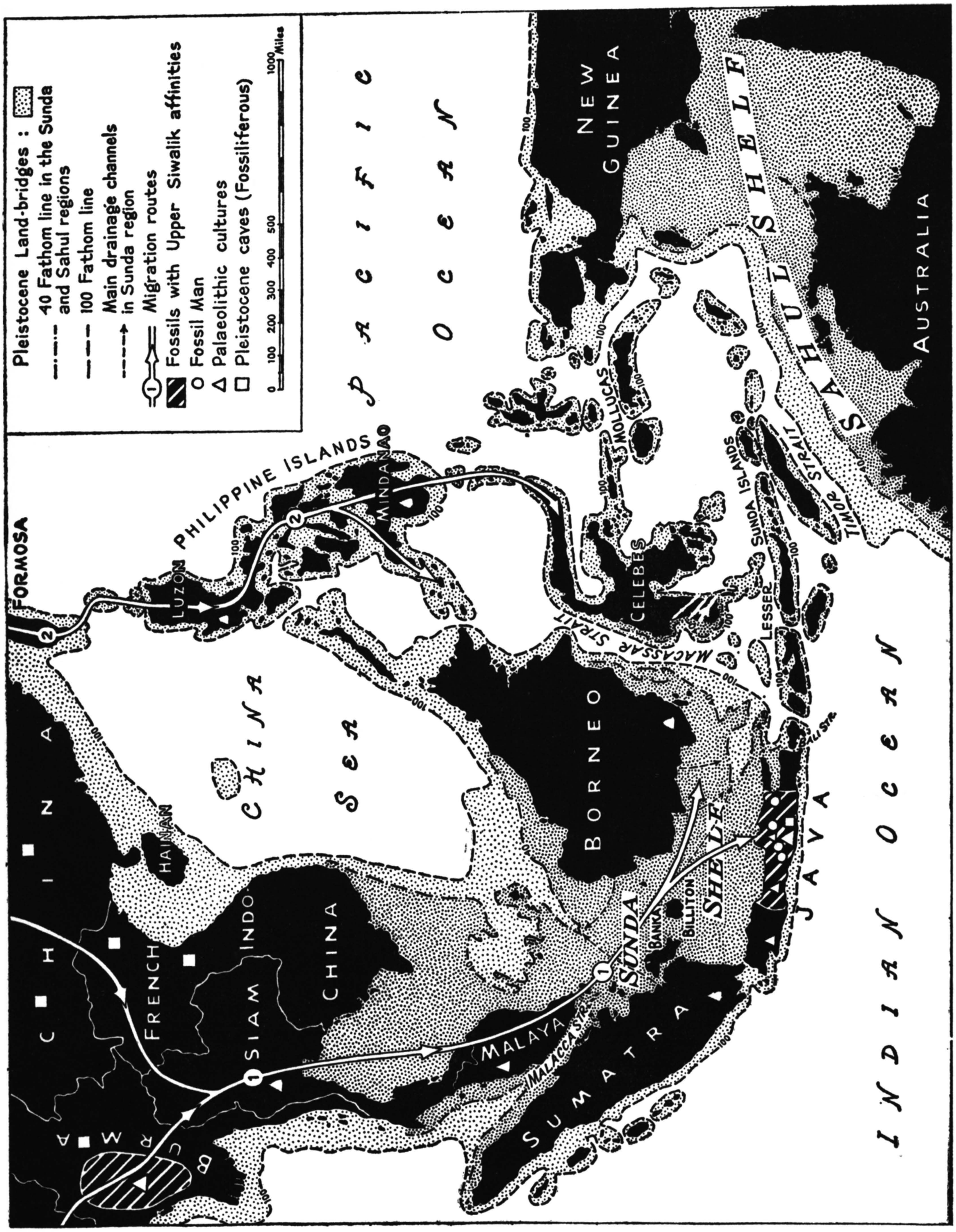
> "During Upper-Pliocene times Java emerged from the sea and was linked to the southern Asiatic mainland. The newly formed peninsula became the habitat of mammals which migrated from the southern portion of Asia."
>
> Hellmut de Terra.

1. CENOZOIC

Geologically, Indonesia is complex. It consists of groups of large and small islands, situated between the Asiatic and the Australian Continents, and extends from 6° N. lat. to 11° S. lat. and 95° to 140° E. long. The Archipelago is a heterogeneous geosynclinal area divided into two dissimilar regions. One, the northwestern region, has been stable since Pleistocene times; it has a quiet, regular submarine relief which consists of two Continental Shelves of extensions of the beach below the sea-level, caused by denudation and sedimentation. The Continental Shelves are the Sunda Shelf uniting Borneo, Sumatra and Java with the Malay Peninsula, and the Sahul Shelf joining Australia, New Guinea and the Aru Islands. The second region, situated in the Southeast, is unstable; it has a considerably active submarine relief and comprises Celebes, the Moluccas and the eastern string of the Lesser Sunda Islands. The small deep-sea basins and troughs east of Celebes are especially notable.[1]

The entire area has an equatorial insular monsoon climate combined with a high temperature, a high humidity and a heavy rainfall. The islands are covered with rain forests, except the eastern part of the Lesser Sunda Islands where savanna landscapes prevail due to the influence of the Australian winter anticyclones. Along the coastal plains mangroves grow, and steep mountains of volcanic origin arise, some exceeding the tree-line. On New Guinea some mountains even reach as high as the snow-line.

[1] Umbgrove; '49, 1—4.



By courtesy of H. de Terra.

Fig. 1.

The fauna of the Greater Sunda Islands corresponds roughly with that of Further India while nearer to New Guinea a penetration of Australian elements is noticeable. In Celebes and Timor the extreme outposts of Australian fauna are to be found. Irregular climatic conditions and the presence of deep-sea basins account for the fact that islands like Celebes, Flores and Timor are less suited to accommodate the larger herbivorous mammals. There sometimes peculiar endemic forms occur.[2]

Indonesia's present population consists of about 80 million inhabitants of which as many as 45 million live in Java. The largest portion comprises Malay (Palae-Mongolian) peoples who are far from homogeneous. They predominate in the western area including Celebes, whereas New Guinea and the adjoining islands are inhabited by Papua-Melanesian peoples. The central zone to the east of Celebes, displays a strong mixture of races.

Java is a part of the Great Sunda Shelf. Like nearly all the other islands of the Archipelago, it emerged from the sea late and contributed little to the origin and evolution of the mammals. From the beginning its fauna immigrated from the Asiatic Continent by way of landbridges. Such a landbridge existed at the end of Tertiary times, but it was severed afterwards. Also during the Pleistocene Java must have been connected repeatedly by landbridges with the Malay Peninsula. This has to be ascribed to a combination of orogenic movements and lowerings of the sea-level during the Glacial stages. The former, however, greatly overshadow the effects of the eustatic oscillations of the latter.

At the close of the Miocene Period the first groups of islands emerged from the sea in places where at present the western Java Plateau and the Southern Mountains of Central Java (Gunung Sewu) are situated. North of these islands was a shallow strait with a few scattered small islands, the forerunners of two anticlines which later developed into the Kendeng Hills and the Northern Limestone Mountains. The former constitute a folded ridge which stands from 350 to 400 metres high and stretches from Semarang in Central Java to near Surabaja in East Java. Both mountain ranges are intersected by the Solo River. There are indications that the tectonic movements of the Kendeng Hills occurred mainly below the sea-level during Tertiary times. Since the Middle Pliocene these tectonic movements exerted a greater pressure and caused the enlargement of the emerged parts of Java. Finally, these parts developed into a narrow peninsula as a younger extension of the Asiatic

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2 de Beaufort; '26.

Continent. The first mammals then had the opportunity to reach Java overland. The Tji Djolang fauna, found north of Bandung, consisting of *Merycopotamus, Stegodon* and a primitive *Hippopotamus,* and the Kali Glagah fauna, known from one site in the neighbourhood of Tegal, Central Java, with *Archidiskodon, Mastodon (Trilophodon) bumiajuensis* and *Hippopotamus simplex* are of Early Pleistocene age. Von Koenigswald correlates the Tji Djolang fauna with the Tatrot Zone of the Siwalik Hills in India. The situation is not entirely clear, and there is no complete agreement yet concerning the stratigraphy of the Siwalik Hills and the demarcation of the Tertiary and Quarternary beds. It has been internationally agreed upon, however, that the Villafranchian marks the beginning of the Pleistocene (18th Session, 1948, International Geological Congress, London). The typical Villafranchian genus *Archidiskodon* is already present in Java in the Tji Djolang and the Kali Glagah faunas, which also deserve a place in the Lower Pleistocene. But the Javanese forms lack the horses, camels, giraffes and most of the antilopes, which were animals of the open plains.[3] On this basis, too, the Tatrot Zone marks the beginning of the Pleistocene.

In this period the eastern part of Java began to emerge from the sea, attended by a phase of powerful volcanic activity which resulted in the formation of belts of volcanoes. One third of the surface of Java is covered with their deposits. Since then the geologic formation of Java was influenced by volcanic activity, foldings, uplifts and downwarps which divided it into a number of synclines and anticlines in an East-West direction. Inland seas filled the depressions. Interfering processes like fluviatile erosion and fluctuations of the sea-level, sometimes happening simultaneously, effected rapid and considerable changes in the topography of Java.

Owing to the Glacial Stage the shallow seas of the Continental Shelves ran dry and this led to the formation of the Greater Sunda region. Now the large mammals were again able to reach Java overland, and as far as possible they followed the alluvial tracts of the newly emerged surface.[4]

The Snellius Cruise[5] succeeded in establishing the topography of the Sunda region as well as the former river system by gravimetric

[3] Hooijer and Colbert; '51, 533—538. Hooijer; '52, 436—443.

[4] de Terra; '43b, 440—41. Von Koenigswald; '35, 188—98.

[5] de Terra; '43b, 461.

investigations. The theory of both J. Croll [6] and A. Penck [7] has been put to the test by G. A. F. Molengraaff and M. Weber on orohydrographic phenomena and by zoo-geographic research. It not only appeared that the boundaries of the Sunda area coincide with the 40 fathom isobath, but also that its coasts bear no traces of elevations. However, there only occur depressions and courses of drowned rivers.[8] Next it became apparent that a main stream had existed formerly which received the rivers of East Sumatra and the Kapuas River of West Borneo. Biological studies have shown that the present piscine fauna of these rivers is still the same. The main stream had its source on a plateau where Bangka and Billiton are situated at present. This powerful stream ran in a northerly direction and debouched into the southern part of the South China Sea; another stream ran southwards and debouched into Macassar Strait.

According to Molengraaff and Weber, the lowering of the sea-level amounted to 72 metres during the Fourth Glacial period and H. de Terra calculated that it probably exceeded 100 metres during the Second Glacial, this being the most extensive retreat of the sea.[9] (Fig. 1).

The current belief that the Tropics have not been subjected to important climatological fluctuations during the Pleistocene should at least be doubted considering the present knowledge of this matter. The investigations of F. E. Zeuner [10] have raised the possibility that cyclic processes, caused by climatic conditions, have affected the whole globe. Eric Nilsson [11] has made a thorough examination of this subject in Abyssinia, Tanganyika and Kenya. Apart from important tectonic movements, he established the existence of three Pluvials and a number of post-pluvial periods during the Pleistocene Period. In his opinion, the rythmic climatologic fluctuations under discussion existed simultaneously all over the world. Of course, the geographic position of the region must also be taken into consideration. Thus in the northern and high mountanous regions, Glacials will occur instead of Pluvials. In the Far East notably in Kashmir and Upper Burma, H. de Terra could establish four Glacials, in the Irrawaddy Basin near Chauck three Pluvials, whilst G. B. Barbour [12] and P. Teilhard de Chardin reached the same results concerning the Yangtze Valley, South China.

[6] Brouwer; '26, 1—33. Croll; 1875.
[7] Penck; '33, 324—39.
[8] Molengraaff und Weber; '21, 395—439. de Terra; '43b, 459—62.
[9] de Terra; 43b, 459—61.
[10] Zeuner; '46.
[11] Nilsson; '41, 1—23.
[12] Barbour; '35, 1—112.

Along zoo-geographical lines, E. Stresemann [13] decided on the following working hypothesis: in the Early Pleistocene, during the first Dry Period, the Tropics were blanketed by grasslands. The grassland birds could choose between two passages, one from Tenasserim, Burma and Malaya to Sumatra and the Lesser Sunda Islands; the other from South China via Formosa to the Philippines, Celebes and the Lesser Sunda Islands. The same passages are recorded by C. G. D. van Steenis for the extension of the alpine flora.[14]

The first Dry Period was followed by the first Pluvial. The rain forests spread to Malaya, North and West Borneo, the Philippines and North Celebes. The savanna landscapes disappeared and the grassland birds with them. This was followed by a second Dry Period, milder than the previous one. The grassland birds made their appearance again. At that time there was only one passage open to them, the one leading to the Lesser Sunda Islands by way of Formosa and the Philippines, since the other route was obstructed by the rain forests. Hereafter the second Pluvial set in and the rain forests reached the extension which but for human interference they would now occupy. Stresemann assumes *at least* two Pluvials in the Tropics during the Pleistocene Period. Further investigations will possibly disclose a correlation between these and the Interglacials on the Asiatic Continent.

Julius Schuster [15] found a fossil arboreal flora in Trinil (Java) just above the chief fossil-bearing bone-bed. The flora comprised 54 species, of which 24 still occur on Java at an altitude of 600 to 1200 metres above sea-level. This would mean that Java then had a climate cooler and damper than at present and the temperature would have been 22—18° C. lower than at present.

Java with its equatorial position and recent emergence from the sea presents a situation of a complicated nature. And it would, therefore, be premature even to propose a correlation between this area and the several periods on the Asiatic Continent.

G. H. R. von Koenigswald [16] subdivides the Pleistocene on Java into Lower, Middle and Upper periods, which are distinguished by three consecutive faunas. The discoveries of a series of fossil early hominids by von Koenigswald and others in the years 1931—38 have placed Java

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[13] Stresemann; '39, 312—425.
[14] van Steenis; '35, 135—263, 289—417.
[15] Schuster; '11.
[16] Von Koenigswald; '34, 185—201. Hooijer; '51a, 278.

in an important position in the world as far as the number of various forms of fossil men is concerned.[17]

The abundance of fossils, however, has to be ascribed to the exceedingly favourable circumstances which have contributed to the preservation of the remains, and by which they could be mineralized. Catastrophic volcanic eruptions produced mud-flows which swept men and animals away and covered their remains. Hermetically enclosed, the organic elements of the bones have been replaced gradually by mineral salts. This process is only possible under extremely favourable circumstances.

2. THE LOWER PLEISTOCENE.

> "The hominids of the Sino-Malayan fauna, as far as they are known at present, represent a fairly continuous line proceeding from small types to gigantic ones ......
> As to their morphological characters, each larger type seems to be more primitive than the next smaller one. In other words, gigantism is a primitive character which has the tendency to diminish as evolution advances." Franz Weidenreich.

A. *The Putjangan Beds.*

North of Modjokerto in East Java, the Kendeng Hills are at their lowest and near the village of Perning they have an altitude of only 50 to 100 metres. Near Klagenblandong lies a well dissected mountain ridge running from east to west, being part of the Kedungwara anticline. The country, in particular along the road to Sumbertengah, is exposed to such a degree that the stratigraphy can be clearly distinguished. The area under discussion is situated in the eastern part of an old marine strait that once comprised a large part of the Solo valley. In later times it was filled up with fine volcanic material by fluviatile and eolian agencies, until the entire basin was full of sediments. Afterwards, it was temporarily flooded again by the sea.

As demonstrated by J. Duyfjes,[18] the stratigraphy of the Putjangan Beds in this area starting with the upper layers, consists of a sediment

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[17] Von Koenigswald; '40, 1—232. Hooijer is rather sceptical about a clear distinction between the Djetis- and the Trinil fauna and predicts that "with further increase of our knowledge of the Pleistocene faunas of Java, we shall have a much less cataclysmic picture of the faunal evolution".

[18] Duyfjes; '36, 136—49. Von Koenigswald; '40, 47—51.

of coarse and fine sandstone (35 m. thick), a marly tuffaceous sandstone with marine molluscs (10 m. thick), a layer of greenish clay (5 m. thick), a coarse sandstone layer (100 m. thick) containing fine-grained and coarse-grained conglomerates and andesite boulders. The lowest section contains deposits of a finely stratified and fine-grained tuffaceous sandstone which constitute the transition to a similar layer (10 m. thick) which contains clay in some places. Beneath it are marly and clayish tuffaceous sandstones, bearing conglomerates and marine molluscs, and here and there big lumps of coral and andesite rocks the size of a head (15 m. thick). Finally, a thick layer of tuffaceous sandstone which at some localities could not be distinguished clearly from the preceding one. At the top of the hill-ridge the fourth layer, consisting of a coarse-grained volcanic sandstone, breaks the surface. Officers of the Geological Survey dug a pit on this spot to collect fossils from this layer. The digging led to the discovery of a fossil infant skull at a depth of only one metre. There could be no mistake this time concerning the Lower Pleistocene age of the skull, because it had been found *in situ* and the layer had been carefully examined geologically as well as palaeontologically by Duyfjes and von Koenigswald. As a mere precaution, the horizon was investigated again in 1938 by de Terra and Movius, who both arrived at the same conclusion. Complete proof was given by de Terra [19] who, after studying the mineralogical composition of the matrix inside the skull and comparing it with samples taken from the pit, found them identical. The possibility of the skull having been washed away from a more recent horizon into an older layer can therefore be excluded. (Fig. 2). Guide fossils of the Lower Pleistocene Djetis fauna have been found on the spot.

Deposits of the same age as those found near Modjokerto have also been recovered in other places, although of a slightly varied composition. Near Sangiran and Trinil they have been more influenced by volcanic activity. The Trinil layer consists of a mud-flow breccia (100 m. thick), overlain by the well-known Middle Pleistocene Kabuh Beds. The breccia itself covers the Upper Pliocene Kalibeng Beds of marine origin. All layers have been affected tectonically and dip to the south.

North of Solo, the uplift of Sangiran, dome-like and flat on the top, which is 6 km. long and 4 km. wide, was exposed by folding to such a degree that its entire stratigraphy could likewise be clearly distinguished. Here, too, the lowest horizons are of marine origin and are covered by

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[19] de Terra; '43b, 442—43.

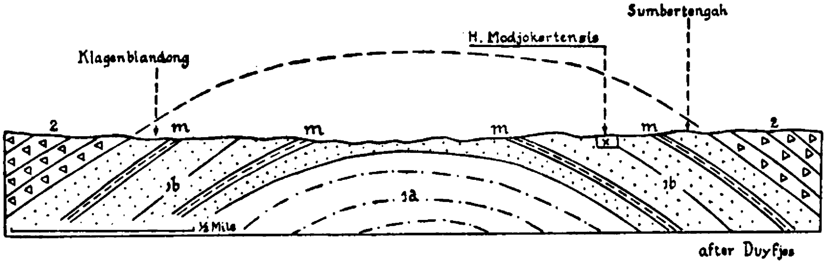

Fig. 2. Geological Section North of Perning near Modjokerto.

1. Lower Pleistocene Putjangan Beds containing the Djetis fauna.
   1a. Marine deposits.
   1b. Fresh-water deposits; m. marine layers.
2. Middle Pleistocene Kabuh Beds containing the Trinil fauna.

x site where the infant skull of Homo modjokertensis was found.

volcanic tuff-breccia (30 m. thick) created by a mud-flow which contains andesite blocks. This layer is immediately followed by a black clay deposited in stagnant pools and marshes, with numerous fresh-water molluscs (200 m. thick). It is interrupted by a black clay and the preceding lowest volcanic breccia yielded guide fossils of the Djetis fauna, as well as remains of three different types of early hominids: *Meganthropus palaeojavanicus, Pithecanthropus modjokertensis* and *Pithecanthropus dubius.*

Bone-bearing beds consisting of black clay containing fresh-water molluscs have also been found at Trinil, Kritjak and Bandjarbangi and they are exposed in some places on the banks of the Solo River. Near Watualang they occur in three places.

The foot of the Butak Hill also starts with marine beds, overlain by volcanic breccia which have been interrupted by tuff-banks. The stratigraphy consists from top to bottom of a tuff-bank (125 m. thick), a tuffaceous sandstone layer and tuff breccias (75 m. thick), banks of tuff (40 m. thick) and sandstone bearing fossils of the Djetis fauna. Thick tuff breccias (200 m. thick) close the horizon.[20]

B. *The Djetis fauna.*

In the entire stretch of the Kendeng Hills there are Putjangan Beds which yield a Lower Pleistocene mammalian fauna. This fauna, however, has not been recognized as a distinct element until recently. L. M. R. Rutten was the first to discover an isolated molar of a primitive *Stegodon* in the vicinity of Modjokerto in 1927. Cosijn described other fossils from

[20] Von Koenigswald; '40, 54.

the area in 1931—1932; in 1934 von Koenigswald and Cosijn visited this region and collected a large quantity of important material, in particular at Sidorjal. They noticed that the collected fauna included species which did not occur in the Trinil Beds, whilst *Stegodon* and *Hippopotamus* were more primitive. Guide fossils are *Cervus zwaani, Antilope modjokertensis* and *Leptobos cosijni.* Von Koenigswald has shown that the Djetis fauna is correlated with the Pinjor Zone in India, but as it also includes evidence of South Chinese influences, he named it a Sino-Malay fauna.[21] For *Ursus, Gibbon* and *Tapirus* are absent in South China as well as in Java. The Djetis fauna has been found in the Putjangan Beds near Sangiran with *Pithecanthropus modjokertensis* and *Meganthropus palaeojavanicus,* and at Modjokerto with a fossil infant skull. In Western Java this fauna occurred in the Tjitarum Valley near Bandung and Subang. Human artifacts have not been found in these oldest layers.

The complete list of the Lower Pleistocene Djetis fauna reads as follows:

PRIMATES:

Meganthropus palaeojavanicus von Koenigswald, *Pithecanthropus modjokertensis* von K., *Pithecanthropus dubius* von K., *Simia satyrus* L., *Symphalangus syndactylus* Desm., *Hylobates leuciscus* Geoffr., *Pithecus pyrrhus* Horsf., *Macaca irus* Cuv., *Macaca sp.*

PROBOSCIDAE:

Stegodon trigonocephalus praecursor von K., *Elephas sp.*

UNGALATA:

Rhinoceros sondaicus Desm., *Rhinoceros kendengensis, Tapirus* cf. *indicus* Desm., *Nestoritherium javanensis, Sus brachygnathus* Dub., *Sus coerti* von K., *Sus sp., Hippopotamus koenigswaldi* Hooijer, *Cervus (Rusa) zwaani* von K., *Cervus (Rusa) probl.* von K., *Cervus (Rusa)* cf. *hippelaphus* Cuv., *Muntiacus muntjak kendengensis* Str. *Tragulus kanchil* Raffl., *Antilope modjokertensis* von K., *Antilope saatensis* von K., *Antilope sp., Leptobos cosijni* von K.

CARNIVORA:

Epimachairodus zwierzyckii von K., *Felis palaeojavanica* Str., *Felis*

[21] Von Koenigswald; '40, 55—57, 67—68.

tigris L., *Paradoxurus sp., Arctictis binturong* Raffl., *Viverricula malaccensis* Gml., *Viverra* div. sp., *Hyaena sinensis, Hyaena sp., Megacyon merriami, Ursus* cf. *kokeni* M. et G. *Ursus malayanus* Raffl., *Lutra* cf. *Palaeoleptonyx* Dub.

EDENTATA:

Manis palaeojavanica Dub.

RODENTIA:

Acanthion brachyrus, Hystrix sp., Rhizomys cf. *sumatrensis* Raffl.

C. *The Early Hominids.*

a. Meganthropus palaeojavanicus von K.

In April 1941 von Koenigswald discovered a fragment of an enormous, massive and primitive mandible near Sangiran. Two molars and the first premolar were still *in situ,* while the greater part of the *alveolus* of the canine was also preserved. The dimensions of this fragment, larger than any observed in a human mandible, surpass even the Heidelberg jaw to a considerable extent; rather they fall within the range of the male gorilla (Fig. 3).

At the *alveolus* of the first molar the jaw measures no less than 44 mm. in height as against 34 mm. in the Heidelberg specimen. The average thickness is 26.5 mm. as against 18.5 mm. in Heidelberg. The antero-posterior length of the molars totals 33 mm.; in Heidelberg this is 25 mm.

Unusually large, 131 mm., is the circumference at the mental foramen level, surpassing even that of the male gorilla, which never exceeds 121 mm., whilst that of Heidelberg measures 92 mm. The jaw is chinless and the buccal surface rounded; its shape is therefore rather simian. But the mental foramen is located exactly at the half-way level of the mandible, as in *Pithecanthropus* as well as in modern man. There is no simian shelf, and the premolars are not specialized; the symphysis, showing the beginning of the mental spine, is essentially human. The jaw is slightly higher, but thicker than that of gorilla. It apparently combines characteristics of both anthropoids and hominids. In spite of its enormous dimensions, it should, as its name already indicates, fall within the range of the early hominids, although it is undoubtedly more primitive than *Pithecanthropus.*[22]

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[22] Weidenreich; '44, 34—55. Hooijer; '51, 265—81. Von Koenigswald: in van Bemmelen; '49, 107. Marks; '53, 26—33.

The dentition which is present is also considerably larger than that of any man, fossil or modern. The form and pattern of the bicuspidate unspecialized premolar resembles that of *Pithecanthropus pekinensis.* It is 10.0 mm. long (Heidelberg: 8.1 mm.) and 12.0 mm. broad (Heidelberg: 9.0 mm.). The crown is badly worn and higher than in Heidelberg and *Pithecanthropus* but on the other hand is surpassed in size by some Krapina molars, as well as by some of modern man. The second premolar is also bicuspid, longer and broader than in *Pithecanthropus,* and exceeds the maximum values of *Pithecanthropus pekinensis.* The cingulum is less developed than in *Pithecanthropus pekinensis.* In spite of wear, it was possible to establish that the first molar had six cusps arranged in a pattern almost identical with that of *Dryopithecus.* It is 15.0 mm. long (maximum length of *Pith. pek.* is 13.6 mm.; of Heidelberg 11.6 mm.; of *Pithecanthropus* B 12.5 mm.) and 13.5 mm. broad (maximum breadth of *Pith. pek.* is 12.6 mm.; of Heidelberg 11.2 mm.; of *Pithecanthropus* B 13 mm.).

F. Weidenreich reconstructed the entire mandible with the dentition, and from this it appears that the massive impression of the jaw is created by a reduction of the length. The data just given have all been obtained from casts described in Weidenreich's monograph.[23] The original remained with von Koenigswald who, because of World War II, had no opportunity to take the measurements himself. Since the jaw has survived the war, we may expect a description by von Koenigswald in the future. It is clear, however, that the mandible belonged to an early form of hominid.

An additional, highly fossilized mandible fragment of *Meganthropus* was found in September 1952 by Dr P. Marks near Sangiran, north of the village Glagahombo. The jaw fragment was weathered out of a hard conglomerate 1½—2 metres thick, and strongly cemented, which forms the boundary between the Kabuh and Putjangan Beds. (Pl. 2). The fragment consists of the right side of the mandible, broken off at the distal end, but including the frontmost part of the *ramus ascendens,* as well as the complete tooth-row P3—M3. The crowns of the teeth except for M3, are broken off.[24]

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[23] Weidenreich; '44, 15. Von Koenigswald: in van Bemmelen; '49, 110.

[24] Marks; '53, 26—33. Le Gros Clark; '55, 86—87, 95. The latter does not agree with a generic separation of *Meganthropus* from *Pithecanthropus* on the basis of dental morphology. "It may readily be admitted that the available fossil material from Java is not yet adequate to decide finally whether there was more than one genus, or more than one species, of hominid living in Java during the Early Pleistocene. But from general consideration the pro-

b. Pithecanthropus dubius von K.

This mandible is only a fragment of the right portion with the first and second molar *in situ;* the root of the second premolar, of which the crown is broken off, still remains in the bone. The fragment was found near Sangiran by von Koenigswald in 1939, and according to the collector, it came from the Putjangan Beds. The dimensions of the jaw fall slightly below the minimum of the gorilla. It is thicker than that of *Pithecanthropus* B., but thinner than that of *Meganthropus.* There is a gradual reduction in thickness from the *torus superior,* where it amounts to 19.0 mm., to the *torus inferior,* where the thickness is 13.5 mm. This feature is decidedly simian and just the reverse of the hominids. But the large mental foramen consists of a single aperture located half-way in the height of the mandible in line with the second premolar, as is usual in the hominids, including *Meganthropus* and *Pithecanthropus.*

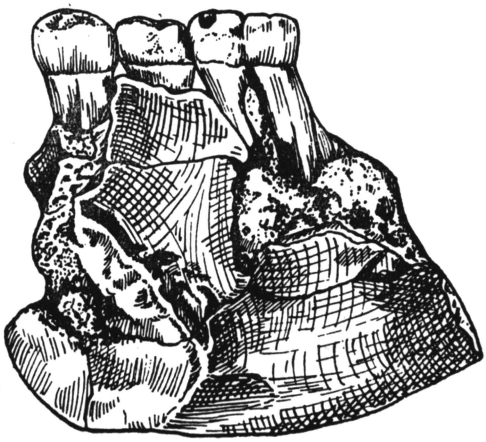

Fig. 3.

babilities seem to be against such a conclusion, and (it must be emphasized again) there is at present no really convincing morphological basis for the recognition of more than one species, *Pithecanthropus erectus*".
Weidenreich who was the first to speak of Giant Man on Java is contradicted by Le Gros Clark in the following way: "Some authorities have interpreted the large mandibular fragments from Sangiran as evidence for the existence on Java during the Pleistocene of giant hominids. This seems to be a misapplication of the term giant, which is commonly taken to refer to stature. But a large hominid jaw does not imply a giant individual. On the contrary, so far as other palaeontological evidence goes, there is some reason for assuming a negative correlation between the size of the mandible and the total stature".

The dentition is arranged in the shape of a horseshoe, another characteristic of the hominids. But the unusually large molars exhibit a decrease in size from front to back, a feature common in the anthropoids. Furthermore the pattern of the dentition points to specialization. The first molar is badly worn, exposing the dental cavity. Its crown is almost square, measuring 13.0 mm. in length and breadth. The second molar is less worn and measures 14.1 mm. in length and 14.3 mm. in breadth. The jaw exhibits no vestige of a mental spine. The *symphysis* is different from *Meganthropus*. Von Koenigswald does not rule out the possibility that the mandible is that of an anthropoid not yet known, in which a number of hominid characteristics are combined. The hominid nature is not yet determined. Supplementary finds are highly desirable and may enable us to delete *Pithecanthropus dubius* from the list of the early hominids.[25]

c. Pithecanthropus B.

The *Pithecanthropus* mandible B (Fig. 4) was also found by von Koenigswald's collectors in 1936. It came from the black clay at Bukuran, near Sangiran. The fragment presents the right side of a heavy mandible, measuring 86.5 mm. in length. The ascending ramus is completely missing. The second premolar and the three molars are still *in situ,* the alveolae of the canine, the lateral incisor and the first premolar are

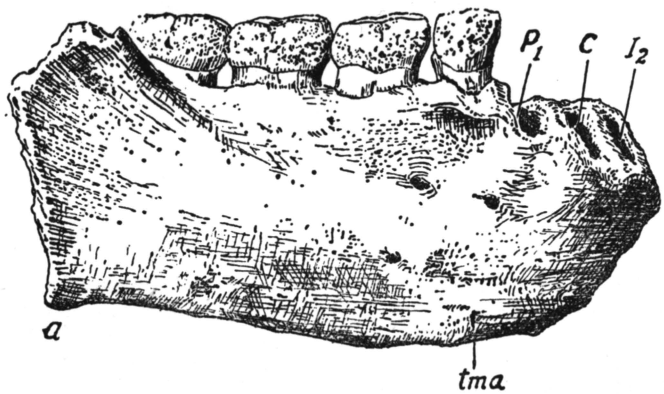

Fig. 4.

[25] Von Koenigswald: in van Bemmelen; '49, 107.

preserved. The alveolus of the incisor must have been relatively small. The size of the molars, still present, increases from front to back. The second premolar, therefore, is exceptionally large, measuring 9.2 mm. in length, and 11.0 mm. in breadth. The first molar is the smallest. The jaw has no interior *torus transversus,* its place being marked by a slight protuberance. Besides, the mandible exhibits three mental foramina, two (the largest) at a higher level than the third, which is a rare feature in hominids. The first and second molar are more or less quadrangular, both having five cusps. The third molar is oval-shaped and has six cusps. The first premolar exceeds the maximum values of modern man in regard to length and breadth and closely approaches the measurements of *Pithecanthropus pekinensis.* The measurements of the three molars as compared with those of *Pithecanthropus pekinensis* are as follows:

Lower teeth	*Pithecanthr. B*	*Pithecanthr. pekin.*
Length of M_1	12.5 mm.	average 12.6 mm.
Length of M_2	13.0 mm.	12.6 mm.
Length of M_3	14.5 mm.	?
Breadth of M_1	13.0 mm.	11.8 mm.
Breadth of M_2	13.2 mm.	12.5 mm.
Breadth of M_3	12.5 mm.	?

This large and massive mandible fragment and the maxilla of *Pithecanthropus modjokertensis,* fit well together.[26]

d. Pithecanthropus modjokertensis von K.

In 1939 von Koenigswald's men found some large cranial fragments of a gigantic early hominid in the Putjangan Beds, near Sangiran. The finds include the posterior half of a brain case and the lower portion of a maxilla. The former fragment consists of almost the entire plate and the floors of the nasal cavity. The teeth, except for the four incisors, of which the alveolae are preserved, and the second and third left molar, are *in situ.* An isolated shovel-shaped upper-incisor was also found.

[26] Von Koenigswald; '40, 140—65. Weidenreich; '44, 56—62.

According to Weidenreich,[27] the skull had been crushed with great force in prehistoric times, causing a dislocation of the component parts. He has examined and studied the casts and was able to reconstruct the whole skull by readjusting the fragments and taking the mandibles of *Pithecanthropus* B, and *Pithecanthropus pekinensis* G_1 as models.

The size of the skull exceeds that of the Middle Pleistocene *Pithecanthropus erectus* to such an extent that its difference cannot be explained as a difference in sex. We may assume that this skull represents a new species of the *Pithecanthropus* group of gigantic size, and more primitive in several respects. Weidenreich proposed the name *Pithecanthropus robustus,* but this has been discarded by von Koenigswald and renamed *Pithecanthropus modjokertensis* or *Pithecanthropus* IV.[28] It is not impossible that *Pithecanthropus modjokertensis* is a direct descendant of the still larger *Meganthropus.* The skull is not only longer, but conspiciously broader than that of *Pithecanthropus* I and II. In his comparative studies, Weidenreich has made use especially of *Pithecanthropus* II as it is more complete than the holotype found by Dubois.

The greatest cranial length is 150 mm. and of *Pithecanthropus* II 136 mm.; the greatest cranial breadth of the present specimen, which is at the base 158 mm. as against 135 mm. in *Pithecanthropus* II. The skull-vault is remarkably low, especially in the occipital region and the obelion. The nuchal plane is very flat. The occipital curvature exhibits an angle of 91°; in *Pithecanthropus* II the angle is 103°, in *Homo soloensis* 91°; in the Rhodesia skull 99°. The skull possesses a peculiar sagittal crest which consists of a series of knob-like protuberances, and terminates on either side in rather protruding supra-orbital ridges. This structure has not been found in the other *Pithecanthropus* skulls or in the anthropoids. The mastoid process is large, projecting downwards and sharply inwards, while it is an insignificant protuberance in *Pithecanthropus* II.

The most interesting feature of the skull is its extraordinary broad maxilla, which unfortunately could not be compared with that of other Pithecanthropoids, since they are all missing. But it must have been a powerful maxilla, provided with thickened areas, and agreeing well with the mandible of *Pithecanthropus* B.

The palate, which is smooth and does not show ridges or furrows, is peculiar. Its length amounts to 75 mm., as against 57.7 mm. in the

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[27] Weidenreich; '44, 17—32. Von Koenigswald: in van Bemmelen; '49, 107—10.
[28] Von Koenigswald: in van Bemmelen; '49, 107—10.

Rhodesian skull. The teeth possess human characteristics, their pattern being quite similar to those of *Pithecanthropus pekinensis,* except that in the latter the *cingulum* is more strongly developed. The canines are small compared with those of the anthropoids; nevertheless they are considerably larger than is found in any other fossil or recent man, and only the largest *Pithecanthropus pekinensis* canine equals them in size. The breadth exceeds the length, as is the case in all human canines, while in the anthropoids it is just the opposite. The canines are slightly higher than the premolars. The second molar is by far the largest of the three, the third the smallest. This, too, is an anthropoid feature. Between the lateral incisor and the canine is a wide interstice *(diastema)* of 6.2 mm.

Below are given the measures of the teeth as taken from the casts made by Weidenreich:

Teeth	Length	Breadth
I_2r	10.0 mm.	10.4 mm.
C r	9.5	11.7
C l	9.5	11.9
P_1r	8.2	12.4
P_1l	8.5	12.4
P_2r	8.2	12.1
P_2l	8.5	12.3
M_1r	12.1	13.7
M_1l	12.3	13.6
M_2r	13.6	15.2
M_3r	10.8	14.0

The dentition combines human and anthropoid characteristics. The lower jaw has no simian shelf. Undoubtedly the skull is the largest and most massive of any known hominid. But in *Meganthropus* which is only represented by a fragment of the lower jaw, this feature was presumably even more gigantic. There is a close relationship with *Pithecanthropus* I and II of the Middle Pleistocene, but *Pithecanthropus* IV is not only larger and more primitive, but also relatively lower. Contrary to these characteristics is the central position of the occipit which is about the same as in modern man.[29] Von Koenigswald's examination of the original has not yet been finished.

[29] Weidenreich; '44, 17—32.

e. Homo modjokertensis von K.

This skull is that of an infant (Pl. 6) and it was excavated, as was previously stated, by employees of the Geological Survey in the Putjangan Beds near Modjokerto in 1936. It belongs to a child about 3 years old, as the fontanels were already closed. The skull was provisionally classified by von Koenigswald under the name of *Homo modjokertensis*. It is difficult to compare with adult examples, since it is not fully grown, and important changes take place at a later age. The bone structure is very fragile. The skull has a distinct vaulted forehead, which gives it a very human appearance. It has no supra-orbital ridges. On the other hand, it possesses certain primitive characteristics, such as the post-orbital constriction, the rather low vault, and the occipital curvature. The length of the skull is 138 mm., the breadth 109 mm., and the length-breadth index is 78.9.

A. J. P. van den Broek compared a cast of the skull with that of a child of the same age of the Pesechem tribe in New Guinea and considered the possibility that the fossil skull, when fully developed, would not differ from that of modern man.

Von Koenigswald inclines to a quite different opinion. He assumes the possibility that the skull belonged to a member of the *Pithecanthropus* group, most probably to *Pithecanthropus modjokertensis*, despite the existence of great morphological differences. This interpretation can be understood only in the light of L. Bolk's foetalisation theory.[30] The main point of this theory is based on Bolk's examination of a dead pregnant chimpanzee. He noticed that the foetus was more human than a full-grown specimen. The skin was hairless, except on the skull. The snout was less protruding and the skull clearly exhibited a bulge of the forehead. The *foramen magnum* was located as in the skull of modern man. The foetal stage in man remains the same along broad lines, but in the anthropoid after it has left the womb a process takes place during growth which results in the gradual recession of the forehead. The *foramen magnum* faces more to the front. Bolk wanted to show that the external factors and natural circumstances have no connection whatsoever with the development of the specific human forehead, but that it is rooted in the organism of the creature: in the ape as in man. The progress of growth in man is more conservative, in the ape more propulsive. Man in his foetal stage is not bound to pass a simian stage; rather it seems that the simian foetus passes a human stage. This human

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30 Bolk; '26.

stage, however, is of a temporary nature. Von Koenigswald thinks that the process of growth in an early hominid took place in the same way as in the ape in many respects. Hence *Pithecanthropus* probably was born with a more or less vaulted forehead, a feature still to be seen in the first years of his life, while the recession of the forehead would take place only at a later age.

In view of the very early geological age of the skull, von Koenigswald's conclusion seems the more acceptable, in spite of the great anatomical discrepancies.[31]

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[31] Von Koenigswald; '36c, 149—57. '40, 116—20.