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New lights on human evolution in Southeast Asia

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Abstract: Until about 1980 the subdivision of Pleistocene human fossils as proposed by von Koenigswald in 1968 was still in use. In the last five years new discoveries were made of Pleistocene human remains in Java which necessitate the reassessment of our evolutionary insight on human evolution in this part of the world.

— It seems there are two groups of *Homo erectus* fossils, i.e.: An early *Homo erectus trinilensis* (cf. *H.e. erectus*), which is morphological primitive and has an age between late Lower Pleistocene and early Middle Pleistocene.
A late *Homo erectus ngandongensis* (cf. *H.e. soloensis*), which is morphologically progressive and has an age between late Middle Pleistocene up to the end of Upper Pleistocene.
— *Homo robustus* (cf. *Pithecanthropus robustus, P. modjokertensis*) is regarded as being on the same hominization stage as *Homo habilis* of Africa and *Pithecanthropus lantianensis* from China.
— There were two main evolutionary lines among Pleistocene hominid fossils of Southeast Asia, i.e. one of *Australopithecus* and the other of *Homo*.
— The earliest wave of human migration from the Asian mainland arrived in Southeast Asia, particularly in Java, at about 1.8 my. BP. This latter coincided with the onset of Gunz glacial. Before this period the Southeast Asian region was still inundated by sea which hampered the southwardly migrational movement of early human beings from Asia.

INTRODUCTION

Charles Darwin and Evolution are two intimately connected phrases. In the 19th century when Europe again paid interest to natural sciences after a long period of undergoing dark ages, the brilliant ideas of Darwin concerning organic evolution were put forward. His concepts on evolution were influenced by outstanding scientist such as Wallace (1823-1913) the evolutionist, Thomas Henry Huxley (1825-1895) the taxonomist working in the Pacific area, Malthus (1766-1834) the sociologist and economist, the botanist Hooker (1817-1911), Chevalier de Lamarck and Charles Lyell respectively a vertebrate paleontologist and geologist. Two famous publications of Darwin are of fundamentally importance for the science of evolution:

1859 - On the origin of species by means of natural selection or the preservation of favoured races in the struggle for life.
1871 - The descent of man and selection in relation to sex.

Eugene Dubois, as young anatomist, was deeply impressed by Darwin's ideas. He reasoned that should man have evolved from an ape, he must have lost most of his hair covering his body. Further he assumed that human evolution more likely took place in the jungles of the tropical areas where life is difficult, and volcanic outbursts and earthquakes added more misery to their lives. With that idea in mind Dubois drafted himself as a medic in the former Dutch colonial army serving in the then known East Indies, now called Indonesia. In fact in doing so, without his knowing, he heralded the beginning of the search for the ancestors of man and into the science of human evolution.

This paper deals with human evolution in the Southeast Asian region with emphasis on Java where most of the fossil finds have been made. Most spectacular is the recent discovery of two human skull fragments regarded as belonging to the controversial *Meganthropus palaeojavanicus*, which is now classified as australopithecine and called *Australopithecus palaeojavanicus*.

THE FOSSIL SITES

Until today Southeast Asian Pleistocene human fossils are only found in Java, although their stone artefacts are scattered on many islands of the Southeast Asian Archipelago. In Java, so far, human fossil sites are restricted to Central and East Java in Trinil, Kedungbrubus, Ngandong, Sangiran, Perning, Patiayam and Sambungmacan (Figure 1). These will be briefly discussed below.

1. Dubois and Trinil

As mentioned above Dubois became a member of the Dutch colonial army serving in the former Dutch East Indies. First he was stationed in Sumatra, where he began digging in caves to find human fossils, but in vain. Then he was transferred to Java and here lucky enough, he got a free hand from the Dutch government to carry out his search and to roam the country. He came to the village Wajak in East Java and recovered two fossil skulls, called *Homo wajakensis*. But these skulls were too modern, and surely not the "missing link" he was looking for. Then he arrived in Kedungbrubus where he found a mandible fragment regarded as of *Pithecanthropus*. The specimen is a juvenile of about five years old (Tobias 1966). More to the west he came to the village Trinil on the right bank of Bengawan (River) Solo. Here, at last, he recovered what he was looking for. It was a fossil skull named later by himself as *Pithecanthropus* (Dubois 1924).

At the time in which the first skull of *Pithecanthropus erectus* was recovered by Eugene Dubois, it seemed that the scientific world was not yet ready for such a controversial specimen. Was it human, albeit a primitive one, or an ape? Or was it the "missing-link" which the paleontological world is waiting for? Those are the questions which have haunted scholars in the science of evolution ever since the specimen was found.

Earlier a German biologist named Ernst Haeckel coined the name "*Pithecanthropus*", or ape-man, in 1889 for a postulated precursor of *Homo sapiens*, the present-day man. He placed the *Pithecanthropus* ape-man two steps below modern men in the evolution tree of the primates, and in doing so he added also the specific designation of *alalus*, or speechless so to say, because he was of the opinion that the ability to talk is an exclusive human trait.

Several years after the skull was recovered a thighbone was found, which morphologically is a modern one and seemingly originating from the same formation in which the skull cap was embedded. Based on this thighbone Dubois therefore gave to his specimen the specific name *erectus*, and hence it became known as *Pithecanthropus erectus*.

It seems that the furor about Dubois' find did not end by naming it *Pithecanthropus erectus*; it just begun and lasted till today with the end not in sight yet. Many names have been introduced since then and various schemes of evolutionary trees suggested for the specimen.

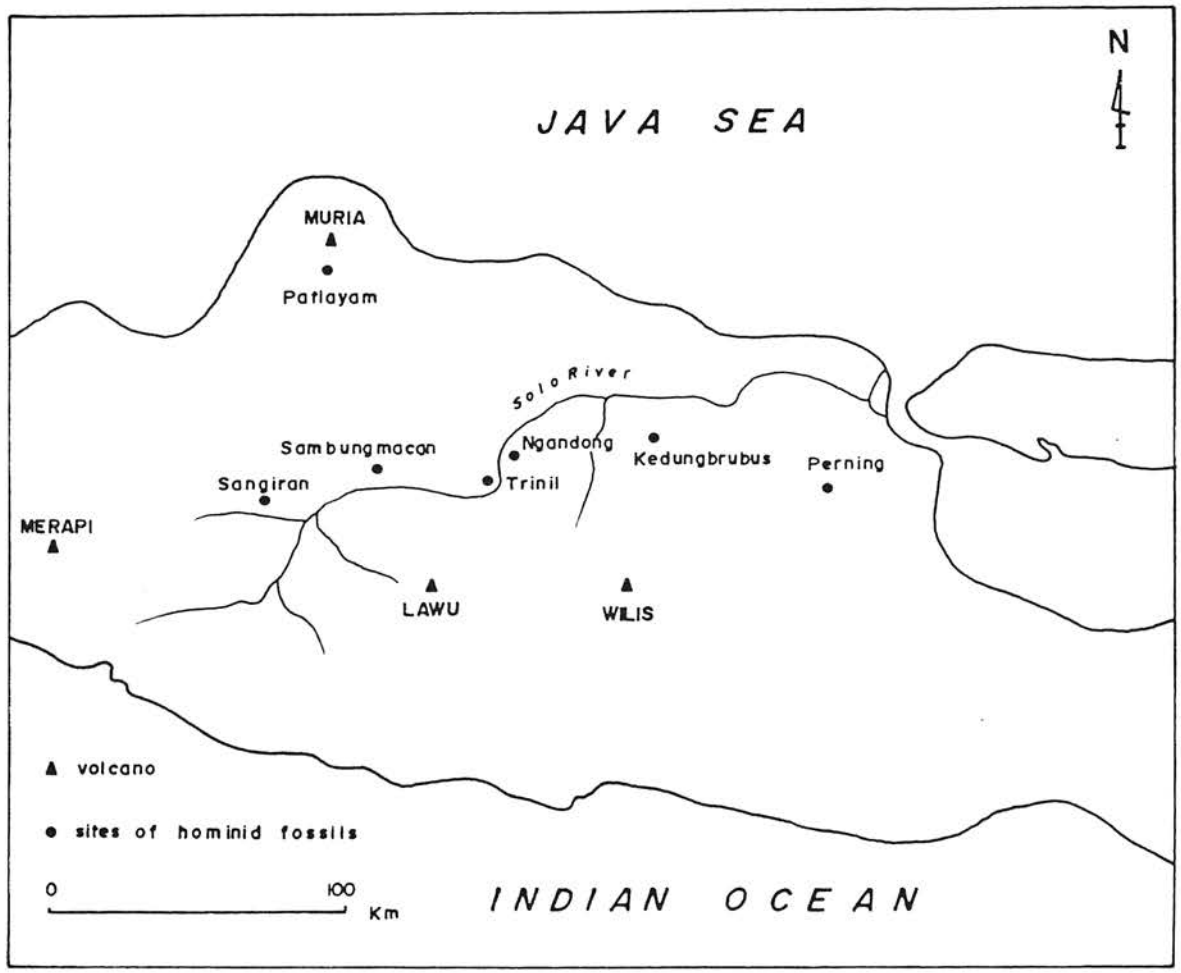

Fig. 1 Sites of Pleistocene hominids in Java.

Indeed the vast number of publications concerning *Pithecanthropus erectus* is entirely in contradiction with the one and only specimen. In the meantime synonyms had been proposed which made matters worse. To mention but a few:

1896 – *Homo pithecanthropus* (Manouvrier).
1899 – *Hylobates giganteus* (Birkner, Boule, Bumuller).
1900 – *Proanthropus* (Martin, McGregor, Mollison, Osborn, Schwalbe, Topinard, Weidenreich, Weinert, Wilser).
1902 – A bastard between man and ape (Branca).
1909 – *Hylobates gigas* (Krause, Klaatsch, Obermaier, Sergi, Voltz, Waldeyer, Virchow).
1921 – A chimpanzee (Rahmstorm).
1921 – A small Neanderthal (Mair).
1922 – *Homo sapiens erectus* (Gieseler, Gregory, Haeckel, Hardlicka, Keith, Kleinschmidt).
1922 – *Homo trinilensis* (Abel, Alsberg).
1924 – A deformed *Homo sapiens* (Minakow).
1932 – *Praehomo asiaticus javanensis* (Black, Dubois, von Eickstedt).

As will be known, after the year 1932 the name *Pithecanthropus erectus* is usually assigned to the specimen. This lasted till about 1950 when it became known as *Homo erectus*.

2. ter Haar and Ngandong

Ngandong is a hamlet on the left bank of Bengawan Solo. Ter Haar, who was a geologist, was undertaking geologic mapping work in the area when he ran into the site (ter Haar 1934). This Upper Pleistocene river terrace contained not less than eleven skulls. These are described and named as *Homo (Javanthropus) soloensis* (Oppenoorth 1932). Some scholars call it simply *Solo Man* (Weidenreich 1951), *neanderthaloid* (Le Gros Clark 1964), *Pithecanthropus soloensis* (Jacob 1973) and *Pithecanthropus ngandongensis* (Sartono 1975a).

3. von Koenigswald and Sangiran

During his many trips around Java, Dubois in fact also arrived in Sangiran, but curiously enough he did not find any human fossils in the area. It was von Koenigswald who got the merit of having his name coined with Sangiran, so far the most richest early human site in Southeast Asia. He not only recovered *Pithecanthropus erectus* specimens (Koenigswald 1940), but other species too: *modjokertensis* (Koenigswald 1968) and *dubius* (Koenigswald 1968), as well as the famous but controversial *Menganthropus palaeojavanicus* (Koenigswald 1941: in Weidenreich 1945).

Outside Sangiran he recovered the fossil *Homo modjokertensis* in Perning near Mojokerto in East Java (Koenigswald 1940), which he thought the same as *Pithecanthropus modjokertensis* because both of them are Lower Pleistocene in age.

4. Post World War II recoveries

After World War II and the following political turbulence in Indonesia had ended, the search for fossil men continued with more sucess than before. Not only more specimen were

recovered but also the number of each species had increased considerably (Figure 2). Most important of those specimens are two skull fragments regarded as *Meganthropus* (Sartono 1982) with certain morphological features known of australopithecinae. These may support the opinion of Robinson (1954) which suggested that *Meganthropus palaeojavanicus* should be called *Australopithecus palaeojavanicus*.

As will be discussed later, using the specimens recovered so far, it is able to propose an evolutionary scheme of hominids found in Java which shows the existence of two genera i.e. *Australopithecus* and *Homo*.

The recovery of an australopithecinae in Java, and recently also in China, shows the wide regional distribution of these hominids. This also suggests that human evolution may have one particular region to start from, but may have arisen at several places on our globe seemingly independant from each other. The first case is called monogenic while the second one is the polygenic concept of evolutionary development of mankind.

TAXONOMIC CLASSIFICATION

Most vertebrate paleontologists believe there were two hominid genera living in Java during the Pleistocene epoch, i.e. *Pithecanthropus* and *Meganthropus*. *Pithecanthropus*, morphologically similar or slightly different to specimens from Java are now known from other parts of the world: in the Chinese mainland, the African continent, Europe, and reportedly also in Vietnam; not to say about the stone artefact which were used by early men and which have a much more extensive distribution than the users themselves. The overall morphology of the specimens suggest that *Pithecanthropus* can be grouped into one species of man, called *Homo erectus*. As a consequence of this new names are introduced for the various specimens recovered from parts of the world, such as: *Homo erectus* (Java), *Homo erectus pekinensis* (China), *Homo erectus capensis* (South Africa), *Homo erectus leakeyi* (East Africa), *Homo erectus mauritanicus* (North Africa), *Homo erectus* (*vertesszollos*: East Europe, *heidelbergensis*: West Europe, *arago*: South Europe) and others. However, there are still enough students in paleoanthropology who prefer the classic name *Pithecanthropus* in favour of *Homo erectus*, or using both terms alternately without preference for one over the other.

Stratigraphic locations of the specimens in relation to their morphological characters indeed suggest that "*Megathropus*" should be separated from "*Pithecanthropus*". This has been proposed also by Koenigswald (1968). *Pithecanthropus IV* is different from *Pithecanthropus erectus*, so Weidenreich (1945) called it *Pithecanthropus robustus* because indeed it is larger than *Pithecanthropus erectus*, but Koenigswald (1968) called it *Pithecanthropus modgokertensis*. This latter being inferred from the specific name of *Homo modjokertensis*, which is thought to be of the same age. However, recent investigations suggest that this juvenile *Homo modjokertensis* is Middle Pleistocene in age, or may be even from Upper Pleistocene, and is old as *Homo (Javanthropus) soloensis* (Sartono *et al.*, 1981), thus not as old as assumed before. Koenigswald regards *Pithecanthropus modjokertensis* as in the same stage of hominisation as *Pithecanthropus (Homo erectus) lantianensis* from China and Homo habilis from Africa (Koenigswald 1968). That is why the present author suggested *Pithecanthropus robustus* (cf. *Pithecanthropus modjokertensis*) be called *Homo robustus* the

Year	Specimen	Original name	Locality	Obtained by
	HOMO ERECTUS NGANDONGENSIS (late Middle Pleistocene - Upper Pleistocene)			
1932/1934	skull	Homo javanthropus soloensis	Ngandong	ter Haar
1969	skull and maxilla	Pithecanthropus VIII	Sangiran	Sartono
1973	skull	Pithecanthropus	Sambungmacan	Jacob
1974	mandible	Pithecanthropus E	Sangiran	Sartono
	HOMO ERECTUS TRINILENSIS (late Lower Pleistocene - early Middle Pleistocene)			
1890/1891	skull	Pithecanthropus erectus	Trinil	Dubois
1890/1891	mandible	Pithecanthropus erectus	Kedungbrubus	Dubois
1934	skull	Pithecanthropus II	Sangiran	v. Koenigswald
1937	skull	Homo modjokertensis	Perning	v. Koenigswald
1938	skull	Pithecanthropus III	Sangiran	v. Koenigswald
1964	skull	Pithecanthropus VI	Sangiran	Sartono and Jacob
1965	molar	Pithecanthropus sp	Sangiran	Sartono
1974	mandible	Pithecanthropus F	Sangiran	Sartono and Koesmono
1975	occipital	Pithecanthropus IX	Sangiran	Sartono
1977	premolar	Pithecanthropus	Patiayam	Sartono and Zaim
1981	mandible	Pithecanthropus	Sangiran	Azis
	HOMO ROBUSTUS (late Lower pleistocene)			
1941	skull	Pithecanthropus IV	Sangiran	v. Koenigswald
1941	maxilla	Pithecanthropus IV	Sangiran	v. Koenigswald
1952	mandible	Meganthropus palaeojavanicus	Sangiran	Marks and Sartono
1960	mandible	Pithecanthropus C	Sangiran	Sartono
1964	maxilla	Pithecanthropus D	Sangiran	Sartono
1965	skull	Pithecanthropus VII	Sangiran	Sartono
	AUSTROLOPITHECUS PALAEOJAVANICUS (early Lower Pleistocene - late Lower Pleistocene)			
1941	mandible	Meganthropus palaeojavanicus	Sangiran	v. Koenigswald
1959	parietalia	Meganthropus I	Sangiran	Sartono
1979	skull	Meganthropus II	Sangiran	Sartono and Djubiantono

Fig. 2 List of Published Specimens of Pleistocene Hominids In Java (Sartono, 1983).

specific name *robustus* having a priority over *modjokertensis* (Sartono 1984a). Thus *Homo robustus* should be separated specifically from *Homo erectus*.

Among *Homo erectus* (cf. *Pithecanthropus*) itself are morphological differences: *Pithecanthropus I, II, III* and *IV* are very much alike. *Pithecanthropus IV* is similar to *VII*, and this is regarded as *Homo robustus*. *Pithecanthropus VIII* shows many similarities with *Homo (Javanthropus) soloensis* (cf. *Pithecanthropus soloensis, ngandongensis, Solo man, Neanderthaloid*). Based on the similarities two groups of *Pithecanthropus* can be distinguished: the early small-brained and the late large-brained one, respectively of Middle and Upper Pleistocene. The small-brained one is represented by *Pithecanthropus erectus*, also called *Homo erectus* (cf. *Homo erectus trinilensis*), while the large-brained group by *Homo (Javanthropus) soloensis*. Some scholars regard it as a neanderthaloid, but not a true neanderthaler of Europe. Now it is usually regarded as a *Pithecanthropus* and called *Pithecanthropus soloensis* (Jacob 1973) or *Homo erectus soloensis* (cf. *Homo erectus ngadongensis*). Moreover it is close to *Pithecanthropus VII*, and that is why this specimen is regarded as belonging to the same group of the late large-brained *Homo erectus* (Sartono 1976).

The most interesting is *Meganthropus palaeojavanicus* found by Koenigswald in1941 (Weidenreich 1945). This mandibular fragment is very robust, the largest of all fossilized mandibles from Java so far. Because of this some regard it is as pathologic specimen (Weidenreich 1945), but by others it is grouped in the family of Australopithecinae (Robinson 1954). A sound mandible was found by Marks (1953), but later identified as a *Homo robustus* (Sartono 1984b). The debate about *Meganthropus* is mainly caused by the fact that earlier no skull has been found of this specimen. But at the end of 1979, a skull was recovered having a crest which suggested it was an Australopithecinae. Parietal and occipital fragments found in 1959 have similar traits as the above skull of 1979. Both specimens are called respectively *Meganthropus I* and *Meganthropus II*, and support Robinson's suggestion to give the name *Australopithecus palaeojavanicus* (Robinson 1954, Sartono 1984a).

To conclude this chapter the following synopsis can be fowarded:

1. So far, from the known published material, there are twenty three skull fragments, six mandibles and three maxillas recovered from the Pleistocene hominid material of Java (Figure 7).
2. Different opinions exist about the taxonomic status of the specimens, but as suggested by Koenigswald (1968) the following calssification is proposed (Figure 3):

Homo soloensis	–	Upper Pleistocene
Pithecanthropus erectus	–	Middle Pleistocene
Pithecanthropus modjokertensis	–	Lower Pleistocene
Pithecanthropus dubius	–	Lower Pleistocene
Meganthropus	–	Lower Pleistocene

3. Reassessment of the taxonomy of the specimens proposed by Sartono (1983) gives the following results (Figure 3).
   a. *Homo (Javanthropus) soloensis* (cf.*Pithecanthropus soloensis, Homo erectus soloensis, Homo errectus ngandongenisis*).

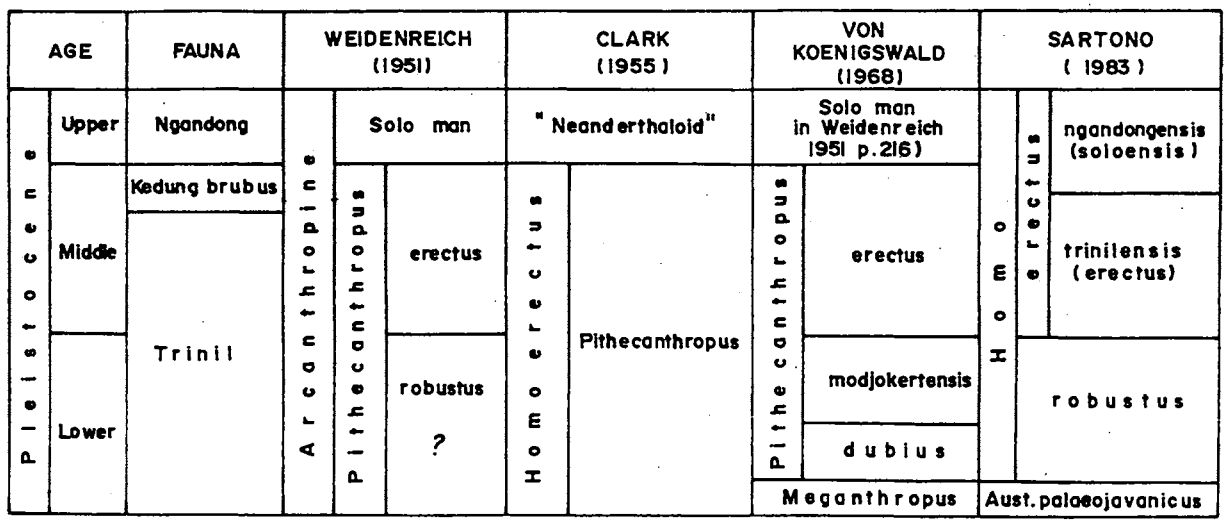

Fig. 3 Nomenclature of Javanese Pleistocene hominids (Sartono, 1983).

b. *Pithecanthropus erectus* (cf.*Homo erectus erectus, Homo erectus trinilensis*).
c. *Pithecanthropus modjokertensis* (cf.*Pithecanthropus dubius, Homo robustus*).
d. *Meganthropus palaeojavanicus* (cf. *Australopithecus palaeojavanicus*).

4. There are two groups of *Homo erectus*: a late large-brained one consisting of *Homo erectus ngandongensis* (cf. *Homo erectus soloensis*), and an early small-brained group embracing *Homo erectus trinilensis* (cf.*Homo erectus erectus*).

DATING RESULTS

During the past several years serious attempts were carried out to establish the ages of early men in Java, in particular those which lived during the Pleistocene epoch. In fact some results were obtained earlier, but these are not based on systematic date from the field. Systematic investigations, among others, by making detailed measured sections on sites, are very important to establish a geological age. Dates obtained from so called "grab-samples" are in fact not suitable although these are better than nothing. Some of the dates obtained in this manner are as follows:

1962 - Koenigswald obtained an age from a basalt from Muria volcano in Central Java amounting to 495,000 (± 100,000 – 60,000) years BP. The rock is part of a collection of R.D.M. Verbeek of the Geological and Mineralogical Institute, University of Utrecht (Netherlands), taken in 1891 in the village Tempur near Japara (Central Java). The dating is carried out by H.J.Lippolt from Max-Planck Institute for Physics in Heidelberg (Germany). In the same Institute Gentner and Zahringer (in Koenigswald 1962) obtained an age of 510,000-690,000 years BP from 25 tectites originating from the area of Sangiran (Central Java). Based on both dates, the age of *Homo erectus (Pithecanthropus) erectus* is established as 550,000 years BP.

1971 - Stross 1971 obtained an age of 1.9 ± 0.4 million years BP based on K-Ar method from a tuff containing pumice from Pucangan formation in the village Jetis near Mojokerto (East Java). Because of this the age of the juvenile skull *Homo modjokertensis* is regarded as almost 2,000,000 years BP.

1971 - Jacob and Curtis (1971) suggested that the above age of 1.9 ± 0.4 million years BP represents also the age of the whole Pucangan formation as well as of the vertebrate Jetis fauna contained in the formation.

1973 - Jacob (1973) obtained an age of 1.91 million years BP from an andesite in the village Kebonduren near Kedungbrubus (East Java). The andesite is regarded as belonging to Pucangan formation which has a thickness of about 400 meters and also contains tuff, tuffaceous sandstone and volcanic breccia.

1975 - Koenigswald suggested that the above age of about 2,000,000 years BP is only acceptable for the upper part of Pucangan formation, but not for the whole formation.

1975 - Issac and Pilbeam (1975) regarded the maximum age of Pucangan formation, inclusive the Jetis fauna, as about 2.0 million years BP. The average age of both, however, may be nearer to 1.0 million years BP.

1976 - Bartstra and Santoso (1976) obtained an age of 0.3-0.5 million years BP, possibly nearer to 0.5 but surely younger that 1.0 million years BP, from rocks which they regarded as belonging to Pucangan formation found in the village Gajah near Trinil (Central Java). The age determination was carried out in the Laboratory for Pure Scientific Research, Isotope Geology, in Amsterdam (Netherlands).

As mentioned above detailed measured sections were made to collect samples for age dating, including the following methods: paleomagnetic, fission-track, and fluorine content. The first two have more or less the same results, the third however displays some differences from the first two. In this connection, in the last several years serious attempts were made to have dates from systematic and detailed measured sections of Plio-Pleistocene sediments with the ultimate goal to obtain exact dates of the early human fossils in Java. Most of these efforts are in the field of paleomagnetic and fission-track dating, although some through fluorine content contained in vertebrate fossils, and other methods too.

Paleomagnetic dating

Several teams were involved in these dating attempts, as follows:

1980 - Yokoyama *et al.* who investigated the Pleistocene series of Sangiran and Trinil (Central Java), especially with regard to the Lower Pleistocene Pucangan formation and the early Middle Pleistocene Kabuh formation, had obtained dates as shown in figure 4.

1980 - Sartono *et al.* who worked in the areas of Central Java (Sangiran, Simo, Klego, Gemolong, Sambungmacan and Trinil), and in the areas of East Java (Kedungbrubus and Perning as well as in Kabuh with emphasis on late Pliocene Kalibeng formation, Lower Pleistocene Pucangan formation and early Middle Pleistocene Kabuh formation), obtained dates shown in figure 4. Results of these paleomagnetic datings, although not exactly the same as obtained by Yokoyama *et al.* (1980), are fairly well in the same magnitude as theirs.

Fission-track dating

1980 - Nishimura *et al.* have dated the tuffs of the Lower Pleistocene Pucangan and early Middle Pleistocene Kabuh formation of Sangiran area in Central Java. The results obtained from these efforts is different from those of paleomagnetic datings, and are in general younger by comparison (Figure 4).

1952 - Bergman and Karsten seemed to have solved the controversy whether the skull of *Homo erectus (Pithecanthroupus) erectus* is contemporaneous with the femur which was obtained in the same bed as the skull. The fluorine content of both materials is of the same order varying between 1.02-1.56%. However, they added, these figures do no conclude that both specimens belong to the same individual, nor to individuals of a single species. But for sure they are of the same antiquity.

1982 - Based on the fluorine content of Pleistocene vertebrate fossils from Sangiran (Central Java), Matsu'ura inferred the stratigraphic locations of the various human fossils in the area. Most of the inferred stratigraphic locations are not the same as reported by earlier investigators (Figure 4).

EVOLUTIONARY SCHEME

The year of 1925 saw the recovery of a very important specimen in Africa by the anatomist Raymond Arthur Dart. This specimen, which is morphologically more primitive than *Pithecanthropus* is a skull with the face intact and belonged to a five to six year old juvenile. It is in every aspect very human, but with a small brain volume, and is called *Australopithecus africanus* ("Southern ape of Africa"), or simply as "the child from Taung". The latter being

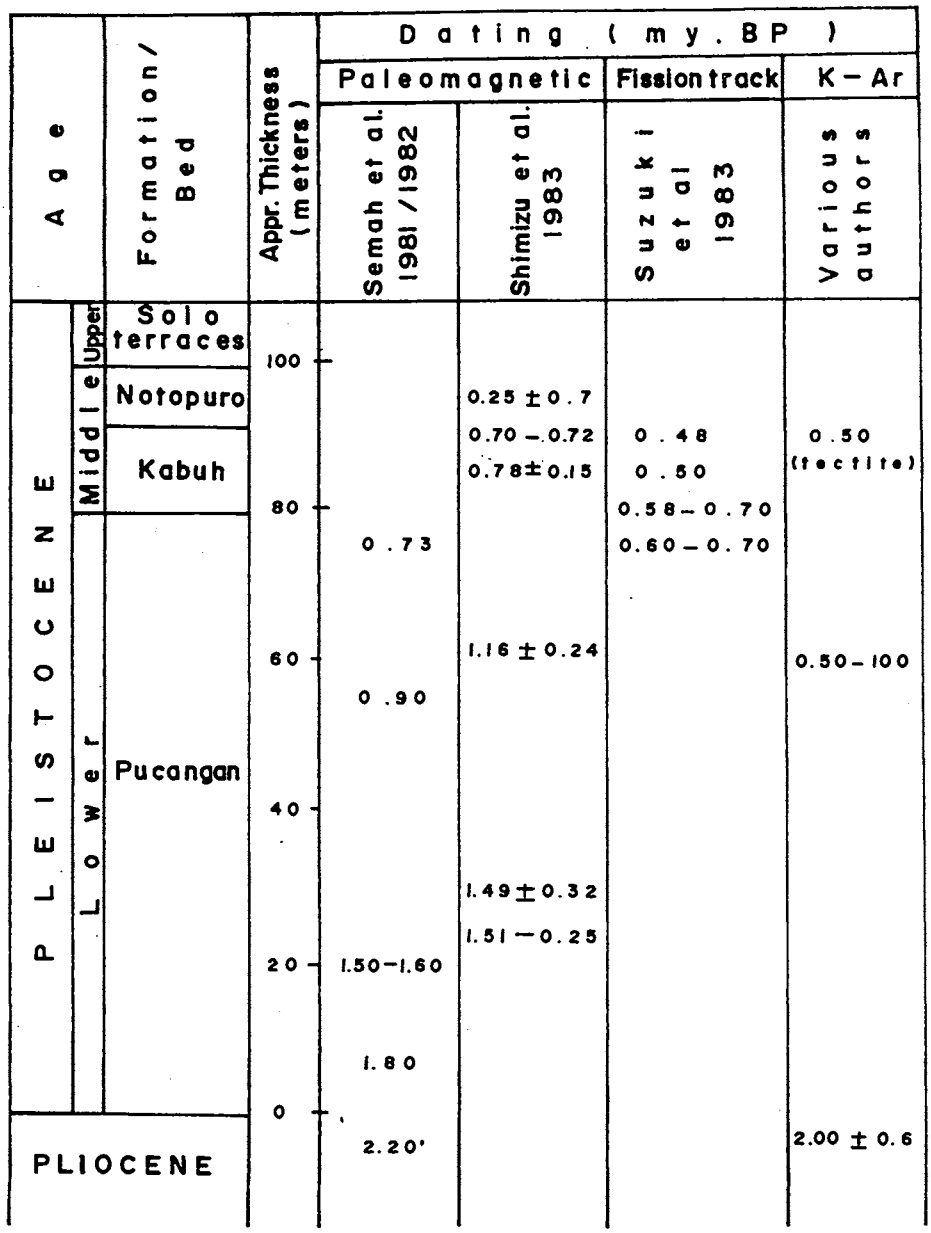

Fig. 4 Chronometric dating of Plio-Pleistocene deposits of Java.

the name of the small village in Kaap Province in South Africa in which the specimen was found. Dart who gave to his specimen the name "—*pithecus*" (ape) and "—*anthropus*" (man), indicated that he regarded it as lower in hominisation stage than *Pithecanthropus*. During the following several decades many more *Australopithecus* specimens have been recovered from the African continent consisting of the following species: *africanus, robustus/boisei and afarensis*. Next to these *Australopithecus* three species of Homo are also recovered, these are: *habilis, erectus* and *sapiens fossilis*. The most primitive one of them is *Australopithecus afarensis* with an age of about 3.5-4.0 million years BP, while *africanus* is about 2.0-3.0 million years BP and *robustus/boisei* about 1.5-2.0 million years BP. The great antiquity of *Australopithecus* specimens preceding those of *Homo* suggests that this continent could be the cradle of mankind. From Africa *Australopithecus* had swarmed all over the globe while evolving into *Homo*. This monogenic concept was accepted by many scholars, until *Australopithecus* fossils were also recovered from the Chinese mainland and from Java during the last several years. These finds suggest that evolution should not be regarded as monogenic anymore, but polygenic.

The most controversial specimen from Java is *Meganthropus palaeojavanicus*. It was recovered in 1939 from the Lower Pleistocene of Sangiran (Koenigswald 1941 in Weidenreich 1945). The specimen consists of the right mandibular fragment with the first molar and both premolars intact. The mandible is very robust and surpasses all mandibles known so far from Java. The size can only be matched with the robust *Austalopithecus* mandibles from Africa. Because it is the only specimen found so far, and without any other specimens to compare with, most scholars working on human paleontology are confused. Their views range from: just another *Homo erectus (Pithecanthropus)* specimen to one with pathological symptoms. Koenigswald (1968) himself who obtained the fossil regarded it as "an independant Asiatic off-shoot in human evolution". Teeth have been collected later on assumed to be of *Meganthropus*. Jacob (1980) described a skull which he tentatively identified as *Meganthropus*. This specimen was found in 1978 from the upper part of Pucangan formation in mid-dome area of Sangiran.

In 1959 and 1979 two skull fragments which are morphologically very different from *Homo robustus* and *Homo erectus* were recovered and described as *Meganthropus* (Sartono 1982). The vault is very thick with strongly developed torus occipitalis with deep nuchal planes and a bulge of occipital crest. From the bregma on and posterior to the occipital is a well developed ridge which in the bregma area is split symmetrically by a cleft. This feature is regarded as a sagittal torus, but not identical as those of *Australopithecus robustus* or of *Australopithecus boisei*. It is a double crest, so to say. Those features are places of attachments for powerful muscles and indicate the specimen to have a robust and heavy mandibles. These point to the robust mandible of *Meganthropus palaeojavanicus* (Sartono *et al.* 1981). This species itself has been regarded earlier by Robinson (1954) as a member of the family australopithecinae by calling it *Australopithecus palaeojavanicus*, to which the author agrees (Sartono 1984b). The specimen was embedded in the lower part of the Lower Pleistocene Pucangan formation, and paleomagnetically dated as between 1.6-1.8 million years BP (Sartono *et al.* 1980, Semah *et al.* 1981).

There is a certain relationship between stratigraphic locations, morphological features and brain capacities with time. As a general rule primitive appearances of human fossils seem to

go hand in hand with smaller brain volumes and the increase of their ages (Figure 4,5 and 6). Two evolutionary branches can be recognized, one of *Australopithecus* and the other of *Homo,* respectively *Australopithecus palaeojavanicus* and of *Homo robustus* with *Homo erectus*. Of the latter, there are two groups, i.e. the early primitive small-brained *Homo erectus trinilensis (erectus)* and the late progressive large-brained *Homo erectus ngandingensis (soloensis)*. This last species shows some relationship with neanderthal man, and this is why some called it a neanderthaloid. Nevertheless the similarity with *Homo erectus (Pithecanthropus)* is much stronger so that it is generally regarded as being a member of this species (Figure 6 and 7).

Homo robustus (cf. *Pithecanthropus robustus, Pithecanthropus modjokertensis*) is in the same hominisation stage as *Homo habilis* from Africa and *Homo (Pithecanthropus) lantianensis* from China. *Homo habilis* is regarded as ancestral to *Homo erectus (Pithecanthropus)* of Africa. *Homo robustus* also shows more resemblances with *Homo erectus (Pithecanthropus)* than with *Australopithecus (Meganthropus) palaeojavanicus*, and seemed to evolve into *Homo erectus (Pithecanthropus)*, rather than being in the evolutionary line of *Australopithecus (Meganthropus) palaeojavanicus* (Figure 7).

The dating results and the stratigraphic location of the specimen suggest that *Australopithecus (Meganthropus) palaeojavanicus* is the oldest species in the human evolutionary history, of Java in particular. It has been dated as 1.5-1.8 million years BP, and its late members may live side by side with the early members of *Homo robustus* (Sartono 1961), of which its lowest stratigraphic location has been established as about one-third of the thickness of Pucangan formation measured from the top (Sartono 1970b). The highest stratigraphic location of *Homo robustus* known so far is found by Marks (1953) in the "Grenzbank" or Border bed between Kabuh and Pucangan formations (Koenigswald 1940). A few meters below this bed the sediment has been palaeomagnetically dated as about 0.73 million years BP (Semah 1981).

The stratigraphic locations and age ranges of the specimens are shown in figure 6 (Sartono 1975) and figure 7, and is also inferred from their content of fluorine (Matsu'ura 1982). Both give reasonably consistent results.

The question concerning *Homo modjokertensis* earns a special consideration. This species found in 1937 in the Perning area near Mojokerto in East Java (Koenigswald 1940) was regarded as originating from the Lower Pleistocene Pucangan formation. There was much debate about this find, i.e. whether it is the same as *Homo erectus (Pithecanthropus)* or as *Homo (Javanthropus) soloensis*. Later on, in 1940, another human fossil was found in Sangiran (Central Java) in the Lower Pleistocene Pucangan formation too. Because of the same formational locations both specimens were regarded as the same too, although the one of Sangiran shows differences from *Homo erectus (Pithecanthropus)*. The specimen from Sangiran is called *Pithecanthropus robustus* by Weidenreich (1945), but later on classified as *Pithecanthropus modjokertensis* by Koenigswald (1968). In this paper the name *Homo robustus* is used for the specimen, thus giving priority over the specific designation of *modjokertensis* which was introduced later. In this connection, it must be added here, that recent investigation do not show *Homo modjokertensis* being embedded in the Lower Pleistocene Pucangan formation but in the Middle Pleistocene Kabuh formation, possibly

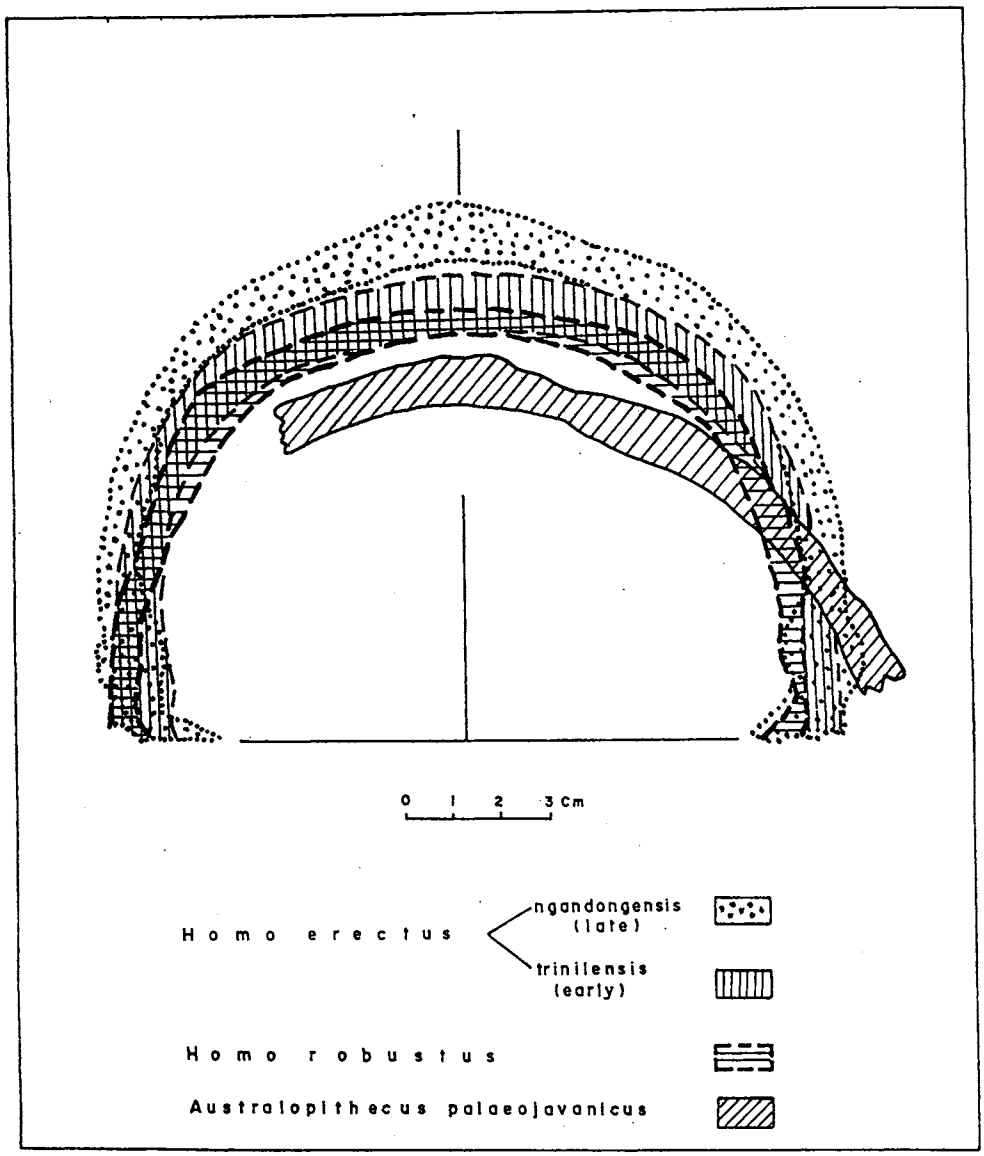

Fig. 5 Comparison of coronal craniograms

even originating from the Upper Pleistocene Jombang beds, (Sartono *et al.* 1981) and that its age is not 1.9 + 400,000 million years BP as assumed before, but this seems to be around 0.73 million years BP (Sartono *et al.* 1981), or may be even younger.

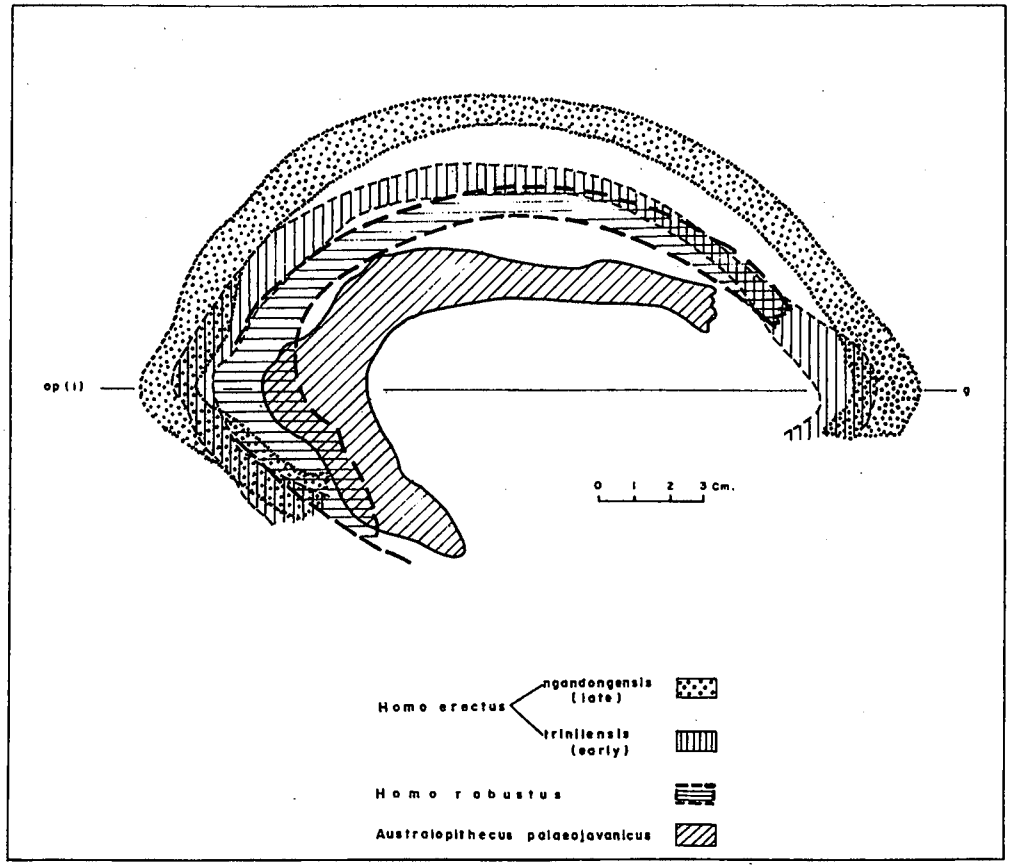

Fig. 6 Comparison of sagittal craniograms.

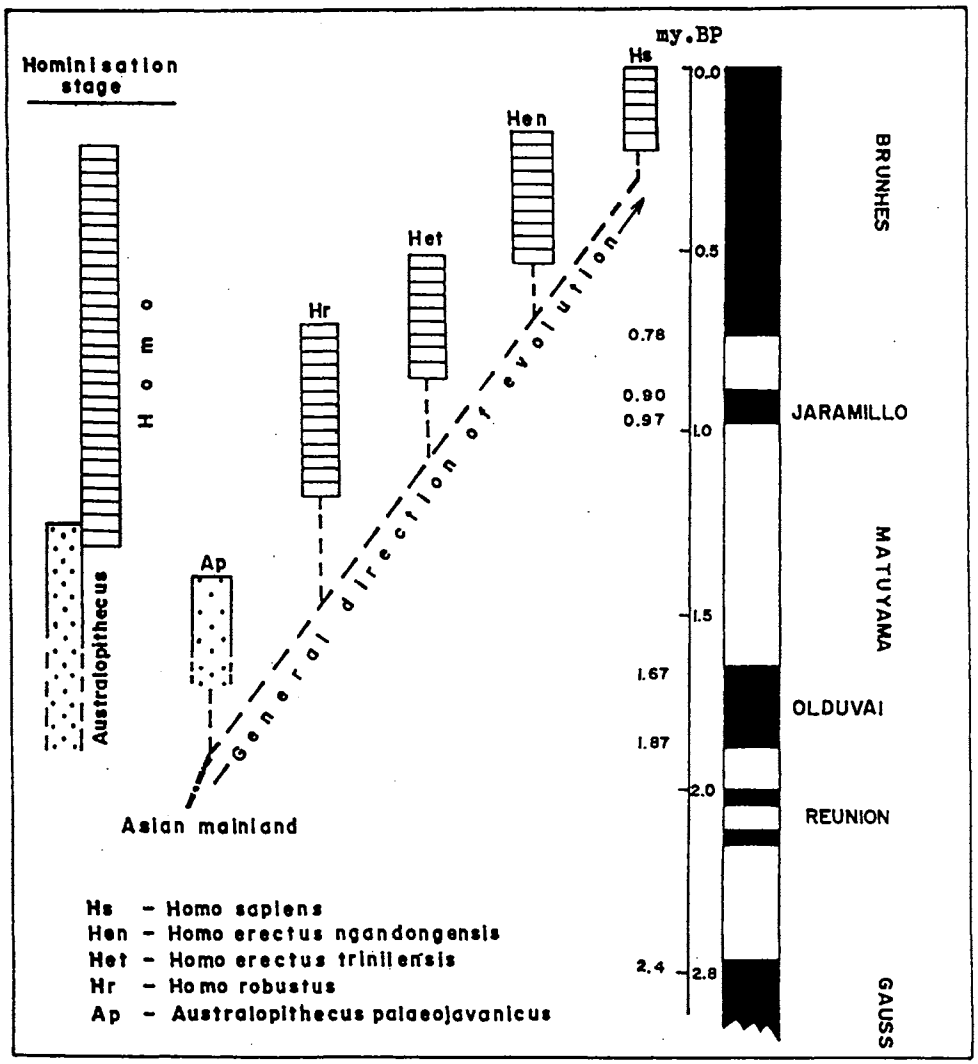

Fig. 7 Scheme of hominid evolution in Java, Indonesia.

Pithecanthropus skull VIII (Sartono 1971) is stratigraphically higher than all *Homo erectus* from Lower and Middle Pleistocene known so far. While it shows some differences from them, similarities also occur between this and *Homo (Javanthropus) soloensis*. That is why both of them are regarded as belonging to the same late group, i.e. of *Homo erectus ngandongensis* (cf.*H.e.soloensis*). To this latter also belongs the skull from Sambungmacan in Central Java. A paleomagnetic date is obtained by Yokoyama *et al*.(1980) from the Middle Tuff layer of Kabuh formation of Sangiran amounting between (0.70-0.72)-(0.78+0.15) million years BP. Supported by its flourine content this date is regarded as the age of *Pithecanthropus VIII* (Matsu'ura 1983). As mentioned above based on K-Ar dating of

tectites found in the Kabuh formation the age of *Homo erectus (Pithecanthropus)* specimens is regarded as between 0.51-0.69 million years BP (Koenigswald 1962) while according to Issac & Pilbeam (1975) the age is about 0.7 million years BP.

From the Notopuro formation of late Middle Pleistocene of Sangiran an age of 0.25 + 0.07 million years BP was obtained by Nishimura *et al.* (1980), but no human fossils have been recovered so far from this formation.

In the overlying Upper Pleistocene terrace deposits in Sangiran, that is the Brangkal terrace (Sartono 1983), so far no human fossils have been found either. But in Ngandong terrace, which is the youngest one in the succession of terrace, stratigraphy of the Solo terraces (Sartono 1975b), ter Haar (1934) recovered not less than eleven fossilized skulls. Dating of these Solo terraces has not yet been carried out, but it is assumed that the age of the human fossils is about 0.06-0.1 million years BP. These human remains are designated as *Homo erectus ngandongensis* (cf. *Pithecanthropus soloensis, Homo erectus soloensis, Homo soloensis, Javanthropus soloensis, neanderthaloid*) and were found in association with the Ngandong vertebrate fauna.

There is also a certain pattern in the stratigraphic locations of the human fossils of Java. *Australopithecus (Meganthropus) palaeojavanicus* is confined to the lowest levels of the Lower Pleistocene Pucangan formation. Higher in the profile is found *Homo robustus* (cf.*Pithecanthropus robustus, Pithecanthopus modjokertensis*) and its age range is up to the upper boundary of the formation, that is Grenzbank (Border bed). The stratigraphic locations of *Homo erectus trinilensis* (cf. *H.e.erectus*) is scattered between the highest levels of Pucangan formation and up to the lower parts of the Middle Pleistocene Kabuh formation. *Homo erectus ngandongensis* (cf.*H.e.soloensis*), however, has an age range from the middle parts of Kabuh formation up to the Ngandong terraces of late Upper Pleistocene.

Time overlap exists in the age ranges of the early human fossils of Java. This indicates a continuity in evolutionary development of the specimens. In this connection two evolutionary branches can be deduced diverging from each other. One branch is occupied by the evolutionary trend of *Australopithecus* and the other by *Homo*. Of this latter, it eventually leads to the present-day man. On the *Homo* branch, *Homo robustus* expresses distinct differences from *Homo erectus* not only in morphological characteristics but also in their age ranges which overlap in the late Lower Pleistocene. Very likely, *Homo robustus* evolved into *Homo erectus*. Among this latter, there are also morphological distinctions and different age ranges between the early and the late groups. The early ones are the *Homo erectus trinilensis* (cf.*H.e.erectus*), while the late ones are the *Homo erectus ngandongensis* (cf.*H.e.solensis*). Taxonomically speaking both are subspecies within one species of *Homo erectus*, or probably they could be races within the early mankind of *Homo erectus*.

Because of the likeness with *Homo sapiens neanderthalensis*, some investigators argue that *Homo erectus ngandongensis* (cf.*H.e.soloensis*), especially in their most latest appearances as represented by the Ngandong skulls, should be grouped within the neanderthaloids. Curiously enough the frontal part of Kow Swamp skull in Australia (Thorne 1971), which has been dated as about 10,000 years BP, has many characteristics in common with *Homo erectus ngandongensis* (cf.*H.e.soloensis*), especially with *Pithecanthropus VIII*. However, some scholars regard the flatness of the vault of the Kow Swamp skull as artificial.

Whatever the disagreements are, many scholars believe that there is a direct link from *Homo erectus* to the present-day Australian aboriginals (Weidenreich 1945, Sartono 1982, Wolpoff *et al.* 1983). If this is true then the human lineage in Java could have been extended as early as *Homo robustus*, some 1.5-1.6 m.y.BP.

The other evolutionary branch occupied by *Australopithecus (Meganthropus) palaeojavanicus* terminated toward the late Lower Pleistocene. It seemed that this species, regarded as an Asiatic off-shoot in human evolution by Koenigswald (1968) arrived at a "cul de sac" and became extinct during that time. Its morphology suggests that *Australopithecus (Meganthropus) palaeojavanicus* is at the same hominisation as *Australopithecus (Paranthropus)* boisei. Both of them also became extinct around 1.5-1.8 million years BP in Africa.

In Africa, another much older species of *Australopithecus* i.e. *Australopithecus africanus* and *Australopithecus afarensis* lived respectively between 2.0-2.5 and 3.5-4.0 million years BP. So far it is not sure yet whether this species also lived in Java. But most probably it was not the case, because during that time Java was still inundated by sea. In this connection, very likely, we must look and search for both abovementioned *Australopithecus* species in the Asian mainland. In Central and Southern China, australopithecinae teeth associated with *Gigantopithecus* are reported by Gao (1975) and Delson (1981). Even in Vietnam human fossils closely related to *Sinanthropus* and *Pithecanthropus* were reported by Vien (1969), respectively from Tan-Van and Kao Leng, both from the area of Lang-So'n, next to *Gigantopithecus* (Davidson, 1975).

The early *Homo erectus trinilensis* (*H.e.erectus*), evolved from the group of hominids to which *Homo habilis* from Africa and *Homo lantianensis* from China as well as *Homo robustus* from Java belonged, and through these in turn from *Australopithecus*. Around the late Middle Pleistocene, the early *Homo erectus* were undergoing morphological changes, i.e. enlargement of cranial volume and decreasing in size of teeth as well as mandibles, and also the loss of heavy bone structures of the skull. In Java, at least, this resulted in the appearance of the late *Homo erectus* as shown by *Pithecanthropus skull VIII*.

In the Upper Pleistocene *Homo erectus* had shed certain anatomical features are maintained such as can be seen with the man from Ngandong terraces of Java i.e. *Homo (Javanthropus) soloensis* (cf.*Homo erectus ngandongensis, H.e.soloensis, Pithecanthropus soloensis*). During its further evolutionary development some *Homo erectus* features still lingered on among Sub-Holocene (Post-glacial) populations, which can be detected in the Kow Swamp skull from Australia of about 10,000 years BP (*Sartono* 1984).

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