LATE *HOMO ERECTUS* OR NGANDONG MAN OF JAVA

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ABSTRACT: Ngandong man of Java is generally regarded as the last representative of *Homo erectus* in Southeast Asia. His remains came from terrace deposits of the Solo river. This paper investigates the age of these deposits, as well as the evidence of stone tools associated with Ngandong man.

KEYWORDS: *Homo erectus*, Ngandong man, Java, Solo river terraces, vertebrate fossils, U-series dating, artifacts.

1. INTRODUCTION

Since 1970 I have had the opportunity to take part in research on fossil man of Java. I am especially interested in the distribution of the Palaeolithic artifacts and the terrace systems of the rivers. The two subjects are closely connected, for the study of the implements of fossil man on Java is impossible without detailed geomorphological surveys. To use a term that was much en vogue at the beginning of this century: on Java one is concerned with so-called river-drift Palaeolithic. The majority of the Palaeolithic artifacts are to be found in fluviatile sediments. There is little chance of finding undisturbed camp-sites dating from the Pleistocene. Any former coastal sites now lie under water as a result of the post-Pleistocene marine ingression, while farther inland layers of volcanic ash and mudstreams, up to several metres thick, cover the land. The caves appear to be devoid of traces of early man.

When Dubois, the discoverer of the first *Homo erectus*, arrived in the East in 1887, he began to excavate caves on the island of Sumatra. But the results were disappointing: remains of early man were absent (e.g. Hooijer, 1948a; 1948b; 1949). There are caves on Java too, and many of them have now been investigated, but early Pleistocene man is not to be found there. Von Koenigswald (1955), who discovered the second *Homo erectus* on Java, provided a psychological explanation: early Pleistocene man avoided the tropical caves because they were unhealthy places, with snakes, bats, and evil spirits. However, this does not explain why later prehistoric man, fully developed *Homo sapiens*, did dwell in caves, on both Sumatra and Java. Gua Lawa (Sampung), for example, a well-known cave in eastern Java, contains cultural remains that are not older than Lower Holocene or Final Pleistocene (van Heekeren, 1972; Hardjasasmita & Mulyana, 1986).

It may have something to do with fire. It may be argued that early man only occupied the tropical caves permanently when he had fully mastered the use of fire. *Homo erectus* on Java, even late *Homo erectus*, perhaps still did not know how to effectively handle fire. Nowhere on Java is there any direct evidence of the use of fire by *Homo erectus*. It has merely been inferred, from evidence from other *Homo erectus* sites elsewhere, that on Java too, *Homo erectus* must have been able to handle fire (Pope, 1985). But the romantic view of the band of *Homo erectus* people sitting around that fire, over which the kill of the big game hunt is being prepared, has come under attack (e.g. Binford & Stone, 1986). It has also been pointed out that the dentition of *Homo erectus* of Java shows traces of wear resulting from a diet mainly consisting of coarse, tough vegetable matter (Puech, 1983).

It is clear that the analysis of the tools used by *Homo erectus* on Java could shed light on behavioural questions of this kind. Unfortunately still far too little is known about these tools. Stone artifacts are to be found all over Java, but only a small percentage of them can be attributed with certainty to *Homo erectus* (Bartstra, 1982; Bartstra & Basoeki, in press). Concerning bone artifacts nothing is certain at all.

With regard to implements and possible behaviour, at the moment we know most about the last representative of *Homo erectus* on Java: Ngandong or Solo man. During the last few years my own fieldwork on Java has concentrated on the evidence of this hominid in particular.

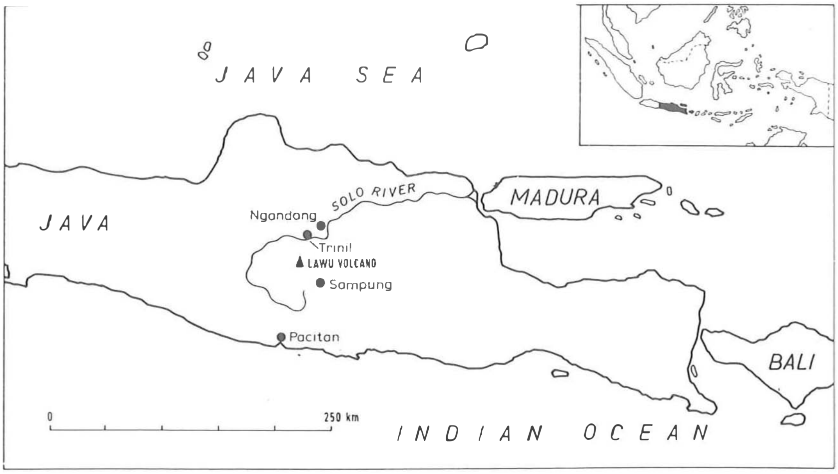

Fig. 1. Map of eastern Java, showing localities referred to in the text.

2. THE DISCOVERY OF NGANDONG MAN

Ngandong is a small village tucked away in the forests of teak (*Tectona grandis*) that cover the Kendeng hills, a low anticlinal ridge in Central Java. The village is situated close to the Solo river, which originates in the mountains of southern Java, subsequently flowing eastwards to the south of the Kendeng ridge, then breaking through these hills, and finally debouching into the Strait of Madura (fig. 1).

It was in the 1930's that the surroundings of Ngandong were first mapped geologically and geographically in detail. The mining engineer ter Haar was entrusted with this task, and during surveys along the Solo banks he found vertebrate fossils. Ter Haar started a small excavation, that was soon taken over and extended by Oppenoorth, at that time head of the Java mapping project. During these excavations, that lasted from 1931 until 1933, a wealth of vertebrate remains were found in old river sediment, among them eleven calvariae and calottes and two tibiae of early hominids.

Oppenoorth (1932a) reported the discovery as *Homo (Javanthropus) soloensis*; ter Haar (1934) later wrote an interesting paper about the circumstances of the find. Subsequently others devoted their attention to Ngandong or Solo man, e.g. Weidenreich (1951), von Koenigswald (1958), Jacob (1978), Sartono (1980), and Santa Luca (1980). Santa Luca describes Ngandong man as a late variety of *Homo erectus* on Java, with robust supraorbital, angular and occipital tori. The average cranial capacity was 1100-1200 cc. The tibiae appear modern in form (see also Day, 1986). The idea that Ngandong man has strong affinities with earlier *Homo erectus* (*Pithecanthropus erectus*) on Java, had already been stressed by e.g. Weidenreich (1945; 1951) and Teilhard de Chardin (1956). Von Koenigswald (1958) stood in fact quite alone in describing Ngandong man as a tropical Neanderthal variety.

In the 1930's an interesting discussion started about the supposed cannibalism of Ngandong man. Eye-witnesses of the original excavations stated that the skulls lay embedded in the river sediments in a rather particular way, in a position in which they offered precisely the greatest resistance to the former stream current: with the concave basal side upwards (ter Haar, 1934). In addition a few of the calvaria show remarkable fractures: the area around the *foramen magnum* is either damaged or even missing (von Koenigswald, 1951). It has therefore been assumed that Ngandong man was a cannibal who ate members of his own species, and that the skulls had been intentionally left behind in a special way; or, alternatively, a more highly developed hominid, who has not yet been found at Ngandong, may have preyed upon this Ngandong man. Notably von Koenigswald (1958) was a proponent of the cannibalistic view. I myself have stated that the arguments in favour of this view appear rather convincing (Bartstra, in press a). Others, however, remain sceptical (Jacob, 1972; Santa Luca, 1980). Yet it is clear that if the use of fire and the practice of big game hunting by *Homo erectus* on Java come under discussion, new light has to be shed also on this supposed cannibalistic behaviour.

3. THE TERRACES OF THE SOLO RIVER

Oppenoorth (1932b) pointed out already that Ngandong man must be younger than the other varieties of *Homo erectus* on Java. This is suggested by not only morphological but also geological evidence. The calvariae and tibiae from Ngandong come from sandy, gravelly stream sediments that show a clear association with the drainage pattern of the Solo river. Earlier *Homo erectus* of Java (Trinil or Java man) comes from stream sediments that cannot be connected with the present-day Solo. The fossil-bearing sediments near Ngandong are so-called terrace deposits, or fossil remnants of a former floodplain, that are now to be found high above the present stream.

The Solo terraces have been a subject of discussion since the beginning of this century. Initially most researchers refused to accept that terrace deposits even existed; in this respect the German geologist Elbert (1908) was an exception. But then ter Haar found vertebrate fossils in stream sediments lying at least 20 m above the present-day river. Moreover, these sediments contain small pebbles of volcanic rock that do not occur in the wide surroundings of Ngandong, and that must have been brought by the Solo from farther south. Thus, in the 1930's it was definitely acknowledged that terrace deposits exist.

Some authors only mention stream terraces in the Solo valley directly to the north and south of Ngandong, where the Solo river cuts through the Kendeng hills. But terrace deposits are also present beyond these hills, where the Solo meanders into a lowland region. There, the old fills are buried under the youngest stream-gravels and sands (fig. 2). This fill-in-fill phenomenon differs markedly from the classic step-like terrace flights near Ngandong.

Lehmann (1936) gave attention to the Solo terraces with regard to geomorphology. He distinguished two terrace levels, that he called the High and the Low terrace, situated 20 m and 5 m above the river. As is to be expected in a tropical climate with severe erosion, the High terrace is dissected. It has only remained preserved in a few sheltered places, like that found near the village of Ngandong. The constituents of the High terrace are distinctly coarser than those of the Low terrace; the latter is known as the 'clay terrace', as the basal conglomerate (if present) lies mostly buried under several metres of silt or clay.

After Lehmann, de Terra (1943) investigated the Solo terraces. He distinguished three levels, and in some places even more. Yet if one tries to trace de Terra's levels in the field one meets with difficulties. One cannot help thinking that de Terra tried to fit real and imaginary Solo terrace levels into a system of four glacials, that was customarily accepted in the 1940's, following the European model. But breaks in the valley slopes that de Terra described as terrace scarps are often impossible to trace in the field (Bartstra, 1977).

Sartono (1976) has mentioned seven Solo terraces. He established the presence of these on the basis of evidence provided by aerial photography. However, the two oldest terraces and the youngest terrace that he distinguished are not true Solo terraces. The two oldest ones have no association with the drainage pattern of the present-day Solo; they date from a time of reversed drainage, when streams flowed southwards from the Kendeng hills. Sartono's youngest terrace can better be interpreted as a modern floodplain feature: low accumulations of cobbles and boulders reminiscent of recent floods. In fact Sartono thus distinguishes four Solo terraces, and in this respect does not differ much from de Terra.

In my opinion for the time being it is better to speak of only a High and a Low terrace along the Solo. A lot of field research will yet have to be done to find out whether the faint breaks that can be traced here and there on the valley slopes can really be interpreted as former terrace scarps. Because of tilting and warping one cannot rely on height measurements alone for the interpretation of terrace levels, and sedimentological analyses are necessary.

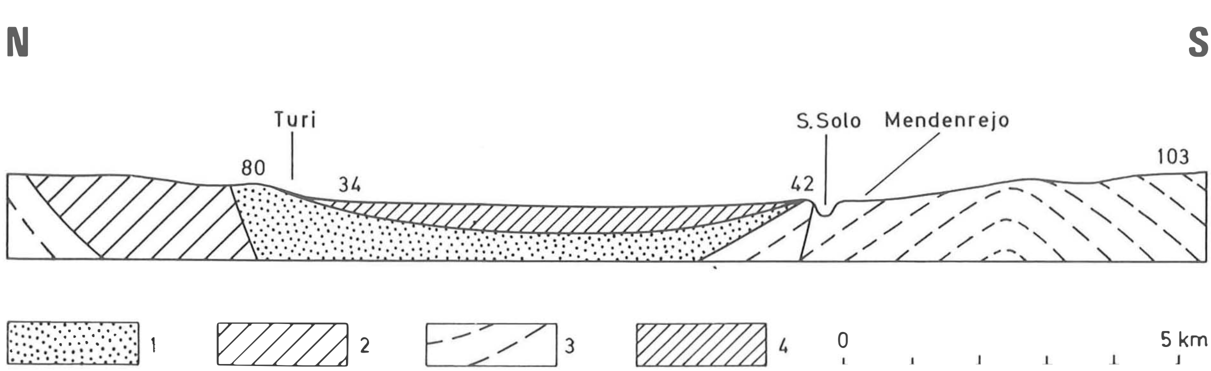

Fig. 2. Cross-section north of Ngandong, showing the fill-in-fill phenomenon: 1. High terrace fill; 2. volcanic bedrock; 3. limestone bedrock; 4. Low terrace fill (modified after van Bemmelen, 1949).

4. THE VERTEBRATE FOSSILS OF NGANDONG

The first reports of the fossils of Ngandong were rapturous. Oppenoorth (1932a; 1932b) acknowledged the extraordinary richness of the fossil-bearing terrace fill, and von Koenigswald (1933), who regularly visited Ngandong during the years of the excavations, referred to it as one of the richest and most important sites on Java. He also indicated that complete vertebral columns and skulls with lower jaws still attached had been found, which is not indicative of much reworking of the animal remains (von Koenigswald, 1951). An interesting feature of the Ngandong vertebrate list is the large number of bovids represented. The horn span of e.g. *Bubalus palaeokerabau* is suggestive of a fauna that was adapted to an open forest environment, as was already indicated by ter Haar (1934), and recently again by de Vos (1985). It would be interesting to provide support for these views by means of pollen research, but a few samples of terrace fill collected near Ngandong in 1986 turned out to be devoid of pollen grains.

Von Koenigswald was employed in the Geological Service of the former Dutch East Indies as a vertebrate palaeontologist. When he arrived on Java, in 1931, it was customary to make an estimate of the age of Tertiary and Quaternary sediments on the basis of the in situ invertebrate fauna. In making such estimates the percentage of recent, still extant species, as well as of fossil species, is of importance (Martin, 1919; van der Vlerk & Umbgrove, 1927). Von Koenigswald tried to apply this method to vertebrate collections, and he succeeded in establishing a vertebrate stratigraphy of Java, extending from the Pliocene until into the Holocene. The differences between the successive faunas were explained by von Koenigswald in terms of migrations from mainland Asia in combination with the isostatic movements of the sea level in the Pleistocene, during which Java was either an island or part of the continent.

When the fauna of Ngandong was excavated, the fauna of Trinil was already well-known. Near this latter village early *Homo erectus* had been found at the end of the last century together with animal remains. Von Koenigswald was able to show that this fauna of Trinil was considerably older than that of Ngandong. Not only could he point to the higher percentage of recent species in the Ngandong fauna, but he was also aware of the fact that the parent sediment of the Ngandong fossils was associated with the present Solo course, which could not be demonstrated at Trinil. Because von Koenigswald regarded the Trinil fauna as Middle Pleistocene, in his view the Ngandong fauna was Upper Pleistocene, and consequently this had also to be the age of Ngandong man or *Homo erectus soloensis* in the modern nomenclature. This age has not been disputed by most palaeontologists.

An exception is Santa Luca (1980), who is of the opinion that the hominid remains from Ngandong could have been reworked, and that they might not be contemporaneous with the rest of the fauna. However, researchers who were present at the original excavations in the 1930's have never expressed any doubts about the uniformity of the material found. Also Jacob (1975) has stated that on the basis of chemical analyses there seems to be no difference between the hominid cranial remains and the animal fossils. Santa Luca's suggestion has probably been prompted by concern about the find of a *Homo erectus* species in relatively young, Upper Pleistocene deposits.

The question leads to taphonomic considerations. The Kendeng hills near Ngandong consist of limestone and marls; only the terrace deposits contain volcanic constituents from farther south. In principle it is possible that from the older deposits eroded by the Solo in the south (the so-called Notopuro and Kabuh layers) fossil fragments have been transported downstream, that consequently in the High terrace must be regarded as allochthonous components. But the distance from Ngandong to the nearest outcrops of these older deposits is at least 30 km (measured along the meandering river). Such a distance is acceptable for small, already fossilized fragments, carried along with the channel-load, but not for eleven hominid skulls. One must therefore assume that the remains of Ngandong man are contemporaneous with the associated fauna and with the High terrace formation of the Solo river.

5. THE AGE OF THE NGANDONG TERRACE

A first attempt to find a relative date for the Solo terraces and for the fossil remains therein, can be made with a reconstruction of the history of the Solo river drainage basin: in fact a reconstruction of geomorphic progress in geologic time, a controversial issue to say the least. Like other disciplines modern geomorphology has turned away from old evolutionary views, and the landscape is now studied in functional, interrelated terms. Unchanged geomorphic relics are viewed with suspicion. Yet the reconstruction of a drainage basin history is only possible on the basis of information provided by relics like abandoned valley floors and fossil floodplains.

Lehmann (1936) has given an acceptable outline of the history of the Solo drainage basin. This outline has never seriously been contested (van Bemmelen, 1949; Sartono, 1976), and the results of my own surveys only strengthen Lehmann's views (Bartstra, 1984). It appears that the Solo initially flowed southwards towards the Indian Ocean (via the now dry valley of Giritontro), and that not earlier than the Upper Pleistocene a northward directed drainage system did develop, as a result of epeirogenic movements in South Java. Consequently the oldest Solo terrace sediments in Central Java must date from the beginning of this northward directed drainage pattern.

Not too long ago the Upper Pleistocene was still a relative concept. But since geomagnetic reversals have been recorded in detail, it has been established that the Upper Pleistocene is the period between the end of the Brunhes normal, 125 ka ago, and the beginning of the Holocene, 10 ka ago. The Middle Pleistocene is congruent with the Brunhes normal, and spans the period from about 715 ka to 125 ka ago. It should thus be ascertained whether radiometric determinations of Solo High terrace deposits or constituents still give good reason for designating these deposits as Upper Pleistocene.

In the Pleistocene stratigraphy of Central Java the Solo High terrace is superimposed on the so-called Notopuro layers, volcanic tuff breccias or lahars and associated stream-laid gravels, which should be connected with the emergence of the Lawu volcano (Duyfjes, 1936; van Bemmelen, 1949; Sartono, 1976). A glance at the map shows that the Solo river partly encompasses this volcanic cone (fig. 1). For the Notopuro deposits there exists one radiometric FT (fission-track) date of 250±70 ka (0.25±0.07 Ma), which comes, however, from pumice pebbles from the fluvial part of these Notopuro sediments and thus is to be associated not with any direct lahar activity but with subsequent river-action (Suzuki et al., 1985). It stands to reason that these pebbles have been derived, and that the FT date marks the onset of the Lawu volcanism towards the end of the Middle Pleistocene. This view is not in disagreement with the few palaeomagnetic determinations that attribute a normal polarity to the Notopuro lahars (Sémah, 1982; 1986).

It has been argued that since part of the Notopuro layers appears to be Middle Pleistocene, the Solo High terrace could still be Middle Pleistocene too (Howell, 1986). A recently obtained U-series date of terrace bone fragments from the surroundings of Ngandong, 165$\pm^{30}_{23}$ ka, would appear to confirm this view (Bartstra et al., 1988). But this date is the result of an analysis of a few small, rounded pieces of bone, that could be allochthonous in the High terrace. Vertebrate bone fragments from a small excavation in the still remaining High terrace remnant at Ngandong itself gave much younger dates, all within the Upper Pleistocene (table 1: 31$\pm^{3}_{2}$ka/101$\pm^{12}_{10}$ ka). Therefore, in my opinion the age of the Solo High terrace, and consequently that of *Homo erectus soloensis*, must still be taken to be Upper Pleistocene.

U-series dates are more disputable than K-Ar or FT dates, because of still unknown factors that influence the outcome of the analysis. So it is sometimes presumed that an outer surface or periosteal probe of vertebrate bone material is preferable to an inner bone analysis. Current research at the Groningen Centre for Isotope Research may lead to a different conclusion, however. As far as the Ngandong terrace bones are concerned, the U-concentrations of the bulk are higher than those of the surface (Bartstra, in press b; van der Plicht et al., in press).

6. THE ARTIFACTS OF NGANDONG MAN AND THE PALAEOLITHIC OF JAVA

The excavations at Ngandong in the 1930's did not result in the find of in situ stone implements. But mention was made of a so-called bone culture: pieces of antler, horns and bones with fracture

Table 1. U-series ages from Ngandong bone samples (modified after Bartstra et al., 1988).

Sample depth	Code	U-concentration (ppm)	^{234}U/^{238}U	^{230}Th/^{234}U	^{230}Th/^{232}Th	^{230}Th/^{234}U age (ka)
B (surface)	G-86656	45	1.092±0.011	0.375±0.033	150±45	51±5
C (1.10 m)	G-86657	12	1.150±0.015	0.342±0.035	26±7	45±5
D (1.20 m)	G-86658	18	1.112±0.013	0.323±0.028	27±6	42±4
E (1.65 m)	G-86659	82	1.207±0.007	0.344±0.040	120±36	45±6
F (1.96 m)	G-86688	128	1.417±0.005	0.409±0.058	*	56$\pm^{10}_{9}$
G (2.20 m)	G-86689	68	1.280±0.006	0.247±0.021	*	31$\pm^{3}_{2}$
H (2.30 m)	G-86690	54	1.252±0.006	0.540±0.040	118±30	82±7
J (2.32 m)	G-86691	74	1.427±0.006	0.489±0.044	*	70$\pm^{8}_{7}$
K (2.50 m)	G-87037	48	1.164±0.011	0.617±0.041	93±31	101$\pm^{12}_{10}$

surfaces assumed to be artifactual (Oppenoorth, 1936; von Koenigswald, 1951). I have always had my doubts about this presumed osteodontokeratic culture from the Solo terraces, but it might be interesting to study the excavated bone collection from Ngandong again, in view of current knowledge with regard to anatomical part-frequencies or artificial marks. It would be very difficult, however, to retrace any significant part of the original collection.

Surface finds of stone tools from the surroundings of Ngandong were mentioned by von Koenigswald (1933), who, during his field surveys in the Kendeng, was able to collect small chalcedony artifacts from High terrace gravel. It stands to reason that this surface gravel is the coarse residue of an originally much more varied terrace fill, and that these artifacts are in fact in situ. They are often abraded, as a result of fluvial transport. In the literature they are referred to as: Ngandong culture, Ngandong industry, or Ngandongian (Movius, 1949; van Heekeren, 1972; Soejono, 1975; Sartono, 1980).

As is the case with river-drift artifacts, they are fairly rare. One has to examine a lot of gravel before an artifact is found. The fact that surface gravel is concerned makes the actual search in the field easier, but nevertheless the Ngandongian artifacts found so far can be spread out on the surface of an average sized table. What then becomes apparent is the absence of the classic, so-called Far Eastern heavy core-types, as defined by Movius (1949): the choppers, the hand-adzes and the hand-axes. Instead, one notices in particular small flakes, rarely exceeding 5 cm in length, and only occasionally transformed into true implements, like scrapers or gravers. The rare cores and core-tools are also small-sized and are very different from Movius' types. I presume that these Ngandongian artifacts can indeed be associated with *Homo erectus soloensis* or Ngandong man (Bartstra et al., 1988).

There exists also a heavy chopper chopping-tool industry on Java, the so-called Pacitan industry, concentrated in the karst/riverine landscapes along Java's south coast. Although this industry can still be called Palaeolithic, it is in my opinion very young, and it dates surely from the second half of the Upper Pleistocene (Bartstra, 1984). This Pacitanian should be associated with *Homo sapiens* (Wajak man?) who inhabited Java at that time.

So one cannot avoid the impression that on Java there is a basic distinction between what I would call the Early Palaeolithic (the Solo High terrace (*Homo erectus*) Palaeolithic) and the Late Palaeolithic (the Pacitanian chopper/chopping-tool (*Homo sapiens*) Palaeolithic; Bartstra & Basoeki, in press). Undoubtedly local differences play a role as a consequence of the former availability of raw material, but a distinction between two tool-inventories is clear. If one assumes (with von Koenigwald's faunal migrations in mind) that *Homo sapiens* came to Java from the continent (Hooijer, 1950; 1952; Shutler, 1984), he could have brought another tool-inventory to the island, in which the heavy core-types dominated. Gradually he may have explored the patches of tropical forest and the caves of Java, which his predecessor *Homo erectus* still avoided.

7. A FINAL REMARK

From the foregoing it emerges that much research needs to be done in Java on the fascinating topic of late *Homo erectus*. From the Solo terraces stratigraphically secured samples of fossil vertebrate material have to be collected in order to verify the U-series dates from Ngandong. More good terrace sections have to be found for the study of the fill-in-fill phenomenon, and lithological probes of the various gravels could help to elucidate High terrace divisions. Terrace outcrops with artifacts have to be mapped and investigated to underline the notion of this basic distinction between an Early and a Late Palaeolithic on Java. There is in fact so much to investigate in the fields of Java, that before satisfactory data can be provided, one needs many more 'geo'-archaeologists. I think that satisfactory data can scarcely result from a short visit to some locality by a single researcher. On Java one needs a well-coordinated team of interdisciplinary workers who can spend adequate time in the field. This is a challenge that has to be met, in the first place by the institutes directly involved: the Pusat Penelitian Arkeologi Nasional in Jakarta, and the Biologisch-Archaeologisch Instituut in Groningen.

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