

## Indonesian *Homo erectus* and Modern Human Origins in Australasia: New Evidence from the Sambungmacan Region, Central Java

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**Abstract** Recent fossil and genetic studies generally support the Recent African Origins Theory as explanatory model of the origins of modern humans. However, the current fossil evidence is still insufficient to reject the competing claim regarding Australasia, that is, the idea of continuity between Javanese *Homo erectus* and modern aboriginal Australians. Recent discoveries of new *Homo erectus* fossils from the Sambungmacan region, Central Java, shed new light on this issue. Preliminary studies suggest their intermediacy, both chronologically and morphologically, between the earlier and later groups of Javanese *Homo erectus*. The evolutionary trajectory of Javanese *Homo erectus* depicted from the more complete fossil record including the Sambungmacan specimens supports discontinuity between *Homo erectus* and *Homo sapiens* in Australasia.

**Key words:** *Homo erectus*, modern human origins, Sambungmacan, Java

### Introduction

Recent advances in fossil and genetic studies now almost unanimously support the Theory of Recent African Origins of modern humans, although the question of the degree of admixture between dispersing *Homo sapiens* populations and local archaic hominids in Eurasia is still debatable (Stringer, 2002). However, this establishment of the overall picture does not mean that all the questions raised by the alternative hypothesis called Multiregional Theory have been answered unequivocally.

Among such questions is the possible contribution of *Homo erectus* in Australasia to the formation of modern aboriginal Australians. There are two major reasons for the multiregionalists to support this possibility: (1) The lineage of Indonesian *Homo erectus* was never an example of evolutionary stagnation. The brain size in this lineage had been increased slowly but steadily, toward the same direction as *Homo sapiens*. (2) There are several unique characteristics shared between Indonesian *Homo erectus* and fossil and modern *Homo sapiens* in Australia (Wolpoff, 1999; Hawks *et al.*, 2000).

Supporting evidence for the Recent African Origins theory is given mainly from different points of view. For example, Swisher *et al.* (1996) raised a possibility that the *Homo erectus* from Ngandong, the chronologically youngest Indonesian *Homo erectus* so far known, may have coex-

sisted with *Homo sapiens* in Indonesia around 50–30 thousand years ago. If confirmed, this would make the evolution from the former to the latter unlikely, but these suggested dates for the youngest *Homo erectus* fossils have constantly been questioned (Grun and Thorne, 1997; Matsu'ura *et al.*, 2000; Antón, 2003; Westaway *et al.*, 2003)

Other disputes to the multiregional way of thinking are on the interpretation of morphological characters in fossil specimens. Many of the characters quoted as supporting evidences for evolutionary continuity between *Homo erectus* and aboriginal Australians (Thorne and Wolpoff, 1981) are revised and re-interpreted in different ways, following the new reconstruction of one of the key fossil specimen of Javanese *Homo erectus*, Sangiran 17 (Aziz *et al.*, 1996). One fossil cranial vault of *Homo sapiens* from the Willandra Lakes, southeastern Australia, has attracted particular attention of multiregionalists because this specimen, WLH 50, shows general robusticity and other peculiar characters that recall the Indonesian *Homo erectus* (Hawks *et al.*, 2000). However, many researchers think this specimen is pathologically deformed and thus cannot serve as evidence of evolutionary continuity (Brown, 1989; Webb, 1990; see also Stringer, 1998, and Westaway, 2006). Also, contrary to the expectation of the Multiregional Theory, the date of WLH 50 is younger than other more gracile (and thus less similar to *Homo erectus*) *Homo sapiens* fossils from Australia (Brown, 1992; Stone and Cupper, 2003).

In summary, morphological primitiveness of Javanese *Homo erectus* and its possible late survival, and other contradictions in specific points of the Multiregional Theory have been the major reasoning of phylogenetic discontinuity between the two groups. However, the current evidences of morphological discontinuity in the fossil record of Australasia are far more ambiguous compared to those documented in Europe between the Neandertals and Cro-Magnon (Mellars, 2004). Further evidences are needed to obtain a clearer picture of the modern human origins in Australasia.

In order to evaluate evolutionary continuity or discontinuity in Australasia, it is important to document not only the primitiveness of chronologically younger Javanese *Homo erectus*, but also evolutionary trajectory in this lineage. If such trajectory directs toward the morphology of *Homo sapiens* (particularly aboriginal Australians), then the Multiregional Theory gains support. On the contrary, if such trajectory is different from the way toward *Homo sapiens*, it becomes more likely that this Javanese lineage was virtually evolutionary dead end.

### The Site of Sambungmacan

Indonesian *Homo erectus* is best represented by the fossil remains from the Early Pleistocene sediments of Trinil and Sangiran, and those from the Middle or Late Pleistocene terrace deposits of Ngandong. However, these two groups are thought to be chronologically separated for more than 500 thousand years. Also, there are some distinct morphological differences between them (Weidenreich, 1951; Santa Luca, 1980). Thus, some fossils that fill this chronological and morphological gap are needed to document evolutionary trajectory in Javanese *Homo erectus*. Such candidates have recently recovered from the Sambungmacan region.

The Pleistocene deposits of the Sambungmacan District, Central Java, have so far yielded four hominid fossils from two localities. One is located at a canal constructed to control seasonal flooding at a meander site of the Solo River. The other is located 4 km to the east (upstream) of the canal site, at another meandering site of the Solo River (Figs. 1, 2).

At the canal site, the first specimen, the Sm 1 skull, was found in 1973 by local workers during the construction of the canal (Jacob, 1996). The second specimen, Sm 2, a mid-shaft of the



Fig. 1. The Sambungmacan canal site (left) and the discovery site of Sm 3 and 4 (right).

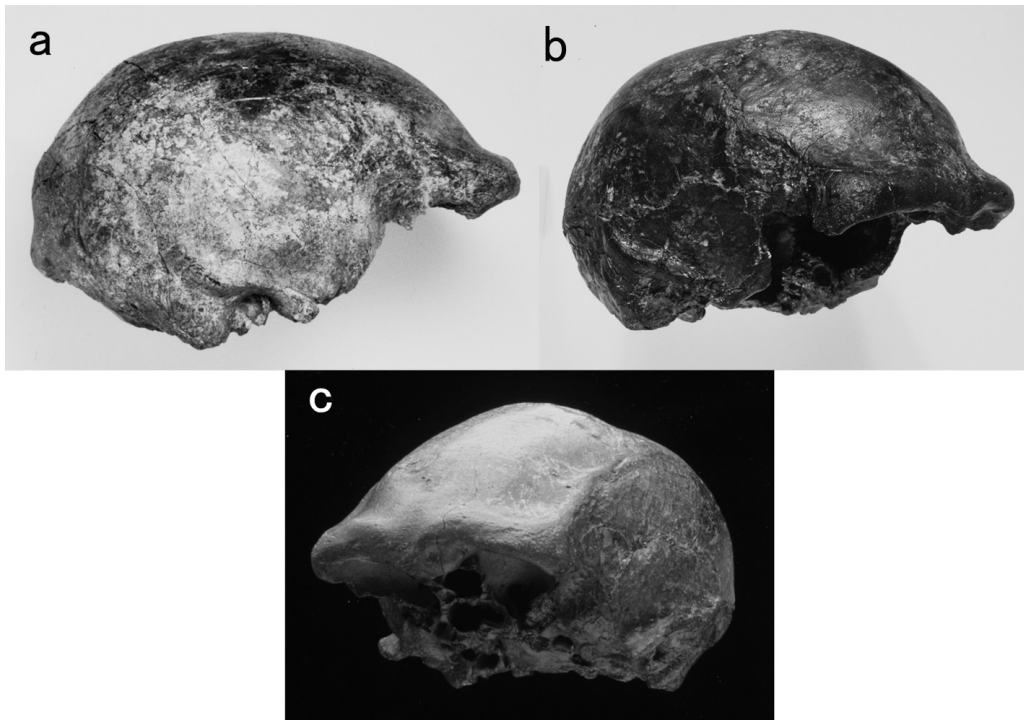


Fig. 2. Three skulls discovered from Sambungmacan. a, Sm 1; b, Sm 3; c, Sm 4.

right tibia, was found in 1977 from the surface collection of vertebrate fossils at the canal site (Baba *et al.*, 1990). In 1997, another skull was discovered by a local worker who was collecting sand from the river bed of the Solo River, about 4 km upstream from the Sambungmacan canal site (Boedhihartono, 1998; Márquez *et al.*, 2001). This skull, Sm 3, had later been brought to New York by an unknown broker, but was returned to Indonesia in 1999. The statement of local workers and our survey around the alleged findspot indicate that Sm 3 had derived from an outcrop somewhere upstream, and been flown down to the site. In October 2001, one more new, virtually complete cranial vault of *Homo erectus* was discovered, again, during the sand collection activity by local workers (Baba *et al.*, 2003). This specimen, Sm 4, is unique in its exceptionally good state of preservation. Most of the important surface characters can be assessed with certain-

ty, and this would help evaluating morphological details in other *Homo erectus* skulls with varying degree of damages.

Among these discoveries from Sambungmacan, Sm 2 is heavily mineralized and thought to have been derived from the earlier Pleistocene deposits (Matsu'ura *et al.*, 2000). However, at the present state of the research, chronological positions of the three Sambungmacan skulls are not yet certain. Swisher *et al.* (1996) reported the age of Sm 1 as about 30 to 50 thousand years ago. However, the findspot of the specimen is not clear and there remains significant doubt about the association of the dated bovid tooth with the hominid skull.

Sm 3 and 4 are considered to have been flown down from outcrops somewhere upstream. The sediments of this area are composed of multiple layers of different ages. The animal fossils accumulated at the findspot of Sm 3 show various colors and degree of fossilization. Thus, it is clear that these fossils had been derived from multiple sources of varying ages. The preservation of the two skulls is also clearly different. Sm 4 is dark brown in color, and exceptionally well-preserved. On the other hand, Sm 3 is darker and surface damage is more extensive. In spite of these complicated factors, it is still possible to narrow down the possible sources of these skulls.

In the 1990's, a Indonesian and Japanese research team surveyed the Sambungmacan area and reported that most of the recorded outcrops of the region belong to the Middle Pleistocene Kabuh Formation (Hasibuan *et al.*, 1995). In addition, the iron bearing sand being collected by local people at the finding site of Sm 3 and 4 shows high content of magnetite and hornblende crystals with small amount of hypersthene, plagioclase and pumice ball. This is a characteristic of the so-called "Kabuh Sand". Thus, both Sm 3 and 4 likely had derived from the Kabuh Formation, and probably they are older than the Ngandong hominid remains. We infer that Sm 1 also derived from a similar context.

### Morphology of the Sambungmacan Skulls

Our extensive comparative analyses indicated that the Sambungmacan skulls, as a group, show intermediate morphology between the earlier and later Javanese *Homo erectus*, while retaining a series of unique features of Javanese *Homo erectus* as a whole (Baba *et al.*, 2003). We examined and compared most of the major cranial remains from Sangiran, Sambungmacan, and Ngandong. All these Indonesian specimens show a set of characteristic features which is not shared with Chinese *Homo erectus* represented by the Zhoukoudian remains. Such features include a comparatively straight supraorbital torus, the lack of a continuous supratral sulcus, and a transversely wide occipital bone.

Based on a review of the previous works and our own observation, we identified 22 characters that differ between the earlier (Sangiran) and later (Ngandong) Javanese *Homo erectus* (Table 1). There may be some degree of inter-character correlations among these items, and the number of characters showing similarities or differences in Table 1 does not necessarily reflect the "genealogical closeness" among the three groups. However, at least, overall intermediate tendencies of the Sambungmacan skulls are apparent.

These results suggest continuous regional evolution of the lineage of Javanese *Homo erectus* without significant contact with other archaic *Homo* populations in the surrounding regions such as northern China (Baba *et al.*, 2003; see also Antón, 2002, and Kidder and Durband, 2004). In other words, Javanese *Homo erectus* was probably substantially isolated from other hominid groups in the Asian mainland such as the Peking Man.

At the same time, Table 1 suggests the existence of several unique morphological specializa-

Table 1. State of differential morphological characters between *Homo erectus* crania from Trinil/Sangiran and Ngandong, and phenetic condition of the Sambungmacan specimens.

	Trinil/Sangira	Sm 1	Sm 3	Sm 4	Ngandong
1. Cranial capacity (cc)	813–1059	1035	918	1006	1013–1251
2. Relatively high vault	(–)	+	+	–	(+)
3. Moderately swollen frontal squama and posterior parietals	–	+	+	int	+
4. Postorbital constriction weaker	–	+	+	+	+
5. Strong temporal gutter	–	int	–	+	+
6. Reduced relative area of temporal muscle attachment	–	+	+	+	+
7. Extremely linear supraorbital torus in front view	–	+?	+	int	(+)
8. Laterally thickened supraorbital torus	–	int	+	+	+
9. No supraglabellar depression with right and left supratoral planes discontinuous	–	int	+	int	(+)
10. Extensive, plateau-like angular torus	(–)	+	+?	+	(+)
11. Antero-posteriorly elongated parietal incisura	–	int	+	int	+
12. Wide supramastoid sulcus	–	int	+	int	(+)
13. Large mastoid with triangular base	–	int	+	int	+
14. Specialized mandibular fossa morphology	–	int	+	int	+
15. Well-developed tympano-mastoid fissure	(–)	int	+	+	+
16. Less extensive digastric fossa associated with well-developed paramastoid crest	–	int	?	int	+
17. Vertically set occipital squama	–	+	+	+	+
18. Marked projection of occipital torus	(–)	–	–	+	(+)
19. Lower arm of occipital torus stronger than the upper	–	int	+	int	(+)
20. Excavated nugal planum	–	–	–	–	(+)
21. Opisthionic recess of foramen magnum	–	?	+	+	+
22. Strong postcondyloid tuberosity	–	?	+	+	+

Symbols + and – indicate presence and absence of the characters, respectively. Parentheses indicate notably variable condition, “int” is intermediate.

tions in later Indonesian *H. erectus*. Although further investigation is needed to confirm their true peculiarities among hominids, we suppose such specialized features include the characters 7–10, 14, 16, 18, and 20–22 of Table 1. Modern Australians apparently lack these unique features of Indonesian *Homo erectus*, and share characteristics of *Homo sapiens* with modern humans in other regions of the world. This observation supports the hypothesis that the lineage of Indonesian *Homo erectus* went extinct without significant contribution to the ancestry of modern humans.

### Summary

The Sambungmacan region, which has recently yielded three well-preserved *Homo erectus* skulls, is a promising paleoanthropological site. The original stratigraphic positions are more or less unclear for all these hominid specimens. However, because the number of the outcrops along the river is limited, it would not be impossible to locate the original stratigraphic levels of the hominid fossils. Information available at present suggests that Sm 3 and 4 are from the Kabuh Formation, and a future study could further narrow down the potential sources of these and other Sambungmacan fossil specimens. The Sambungmacan hominid remains are important because they probably fill the gap existed in the previous fossil record of Javanese *Homo erectus*. The results of our comparative analyses suggest that they represent the middle phase of the evolutionary trajectory of Javanese *Homo erectus* that had continued from the earlier Early Pleistocene. The morphological specialization seen in the late group of the lineage suggests that Javanese *Homo*

*erectus* was substantially isolated and made minimal contribution to the ancestry of modern humans in Australasia.

## References

- Antón, S. C., 2002. Evolutionary significance of cranial variation in Asian *Homo erectus*. *Am. J. Phys. Anthropol.* **118**: 301–323.
- Antón, S. C., 2003. Natural history of *Homo erectus*. *Yrb. Phys. Anthropol.*, **46**: 126–170.
- Aziz, F., H. Baba & N. Watanabe, 1996. Morphological study on the Javanese *Homo erectus* Sangiran 17 skull based upon the new reconstruction. *Geological Research and Development Centre, Paleontology Series*, **8**: 11–25.
- Baba, H., F. Aziz & N. Watanabe, 1990. Morphology of the fossil hominid tibia from Sambungmacan, Java. *Bull. Natn. Sci. Mus., Tokyo, Ser. D*, **16**: 9–18.
- Baba, H., F. Aziz, Y. Kaifu, G. Suwa, R. T. Kono & T. Jacob, 2003. *Homo erectus* cranium from Pleistocene of Java. *Science*, **299**: 1384–1388.
- Brown, P., 1989. Coobool Creek: A morphological and metrical analysis of the crania, mandible and dentitions of a pre-historic Australian human population. *Terra Australis* **13**: 1–205.
- Brown, P., 1992. Recent human evolution in East Asia and Australasia. *Phil. Trans. R. Soc. Lond. B*, **337**: 235–242.
- Boedhihartono, 1998. A new *Homo erectus* finding. *Anthropologi*, **54**: 121–125.
- Grün, R. & A. G. Thorne, 1997. Dating the Ngandong humans. *Science*, **276**: 1575.
- Hasibuan, F., K. Mano, E. E. Susanto & U. L. Batu, 1995. Geology of Sragen area. *Geological Research and Development Centre, Special Publication* **17**: 30–33.
- Hawks, J., S. Oh, K. Hunley, S. Dobson, G. Cabana, P. Dayalu & M. Wolpoff, 2000. An Australian test of the recent African origin hypothesis using the WLH-50 calvarium. *J. Hum. Evol.*, **39**: 1–22.
- Jacob, T., 1976. Early populations in the Indonesian region. In Kirk, R. L. & A. G. Thorne (eds.), *The Origin of the Australians*. Australian Institute of Aboriginal Studies, Canberra. pp. 81–93.
- Kidder, J. H. & A. C. Durband, 2004. A re-evaluation of the diversity within *Homo erectus*. *J. Hum. Evol.*, **46**: 299–315.
- Márquez, S., K. Mowbray, G. J. Sawyer, T. Jacob & A. Silvers, 2001. New fossil hominid calvaria from Indonesia Sambungmacan 3. *Anat. Rec.*, **262**: 344–368.
- Matsu'ura, S., M. Kondo, F. Aziz, Sudijono, S. Narasaki & N. Watanabe, 2000. First known tibia of an early Javanese homonid. *Curr. Anthropol.*, **41**: 297–300.
- Mellars, P., 2004. The impossible coincidence. A single-species model for the origins of modern human behaviors in Europe. *Evol. Anthropol.*, **14**: 12–27.
- Santa Luca, A. P., 1980. *The Ngandong Fossil Hominids: A Comparative Study of a Far Eastern Homo erectus Group*. Dept. Anthropology, Yale Univ., New Haven.
- Stone, T & M. L. Cupper, 2003. Last Glacial Maximum ages for robust humans at Kow Swamp, southern Australia. *J. Hum. Evol.*, **45**: 99–111.
- Stringer, C., 1998. A metrical study of the WLH-50 calvaria. *J. Hum. Evol.*, **34**: 327–332.
- Stringer, C., 2002. Modern human origins: progress and prospects. *Phil. Trans. R. Soc. Lond. B*, **357**: 563–579.
- Swisher, C. C. III, G. H. Curtis, T. Jacob, A. G. Getty, A. Suprijo & Widiasmoro, 1996. Latest *Homo erectus* of Java: potential contemporaneity with *Homo sapiens* in Southeast Asia. *Science*, **274**: 1870–1874.
- Thorne, A. G. & M. H. Wolpoff, 1981. Regional continuity in Australasian Pleistocene hominid evolution. *Am. J. Phys. Anthropol.* **55**: 337–349.
- Webb, S., 1990. Cranial thickening in an Australian hominid as a possible palaeoepidemiological indicator. *Am. J. Phys. Anthropol.*, **82**: 403–412.
- Weidenreich, F., 1951. Morphology of Solo Man. *Anthrop. Pap. Am. Mus. Nat. Hist.*, **43**: 205–290.
- Westaway, M., 2006. The Pleistocene human remains collection from the Willandra Lakes World Heritage Area, Australia, and its role in understanding modern human origins. *Natn. Sci. Mus. Monogr.*, **34**: 127–138.
- Westaway, M., T. Jacob, F. Aziz, H. Otsuka & H. Baba, 2003. Faunal taphonomy and biostratigraphy at Ngandong, Java, Indonesia and its implications for the late survival of *Homo erectus*. *Am. J. Phys. Anthropol. Suppl.*, **36**: 222–223.
- Wolpoff, M. H., 1999. *Paleoanthropology*, 2nd ed. McGraw-Hill, New York.