JASs *I*nvited *R*eviews
Journal of Anthropological Sciences
Vol. 87 (2009), pp. 7-31

Southeast Asian and Australian paleoanthropology: a review of the last century

Arthur C. Durband

Department of Sociology, Anthropology, and Social Work, Texas Tech University, MS 41012 Holden Hall 158, Lubbock, TX 79409-1012, USA
e-mail: arthur.durband@ttu.edu

Summary - *A large and diverse body of scholarship has been developed around the fossil evidence discovered in Southeast Asia and Australia. However, despite its importance to many different aspects of paleoanthropological research, Australasia has often received significantly less attention than it deserves. This review will focus primarily on the evidence for the origins of modern humans from this region. Workers like Franz Weidenreich identified characteristics in the earliest inhabitants of Java that bore some resemblance to features found in modern indigenous Australians. More recent work by numerous scholars have built upon those initial observations, and have contributed to the perception that the fossil record of Australasia provides one of the better examples of regional continuity in the human fossil record. Other scholars disagree, instead finding evidence for discontinuity between these earliest Indonesians and modern Australian groups. These authorities cite support for an alternative hypothesis of extinction of the ancient Javan populations and their subsequent replacement by more recently arrived groups of modern humans. Presently, the bulk of the evidence supports this latter model. A dearth of credible regional characteristics linking the Pleistocene fossils from Java to early Australians, combined with a series of features indicating discontinuity between those same groups, indicate that the populations represented by the fossils from Sangiran and Ngandong went extinct without contributing genes to modern Australians.*

Keywords - *Java, Australia, Pleistocene, Modern Human Origins,* Homo erectus.

Introduction

It would be hard to overstate the importance that Eugene Dubois had for the early development of paleoanthropology as a science. While his reasoning for searching for early humans in Indonesia may have been somewhat misguided in hindsight (Southeast Asia is home to the gibbon, whom Dubois considered to be our closest living relative despite Darwin's arguments supporting the African apes for that role), his discoveries of human fossils at Trinil set the stage for a heated debate that continues to this day. Southeast Asia may no longer be a center for research into the earliest stages of human evolution, but it has remained important for the debate over the origins of modern humans. While the early arguments between Dubois and Ralph von Koenigswald over the finds from Trinil and Sangiran are certainly important and make for fascinating reading, most workers would argue that Franz Weidenreich has had more impact on the modern debate over modern human origins. Weidenreich (1943: 276) contended that "[t]here is an almost continuous line leading from *Pithecanthropus* through *Homo soloensis* and fossil Australian forms to certain modern primitive Australian types." This observation laid the groundwork for what has become the modern Multiregional Hypothesis of modern human origins. This hypothesis states that "various features of modern humans had separate roots in different regions, and that these features spread by gene flow and population movements until they prevailed" (Wolpoff, 1999: 565). This model further posits that there was not a single geographical origin for modern humans, and that modern humans are not a distinct species from preceding archaic forms (Wolpoff, 1999). Thus, in the case of Australasia, the archaic Indonesians discussed by Weidenreich (1943) formed at least a portion of the ancestry for modern Australians. These ideas have been expanded by other workers such as Thorne (1975, 1976, 1977; Thorne & Wolpoff, 1981), Macintosh (1963, 1965, 1967a, b), Kramer (1989, 1991), Curnoe (2007), and Wolpoff (1989, 1992, 1999), and these studies have contributed to the perception that the Australasian fossil assemblage represents one of the best cases for regional continuity in the origin of modern humans.

Much of the interest currently focused on these regional characteristics in Australasia can be credited to the "Center and Edge" model of Thorne and Wolpoff (1981). In that paper the authors propose a theory to explain the mechanism behind regional continuity as well as providing one of its more famous examples: the facial similarities between the Indonesian *Homo erectus* fossil Sangiran 17 and the modern Kow Swamp material (Thorne & Wolpoff, 1981). Other work has linked the WLH 50 partial cranium from Australia with the Ngandong crania (Hawks *et al.*, 2000; Wolpoff *et al.*, 2001), and the mandibular sample from Sangiran with modern Australian Aborigines (Kramer, 1989, 1991). This work emphasizes the persistence of several morphological characters in the skulls, jaws, and teeth of these specimens that potentially provide evidence for the maintenance of genetic cohesiveness in the region for well over a million years.

Recent work has highlighted several potential difficulties with this theory of regional continuity, however. Moreover, these studies often provide support for an alternative scenario for modern human origins that interprets the appearance of modern humans in a particular region as a replacement event with little or no genetic continuity with any preceding archaic populations. While there are several variations of this model, the most commonly cited form is Recent African Evolution or the so-called "Out of Africa" hypothesis. This idea states that modern humans arose in a single geographical location, most likely Africa, and subsequently spread throughout the world and replaced any indigenous archaic populations (e.g. Stringer & Andrews, 1988; Stringer, 1989, 1992, 1994). Thus, in Europe the Neandertals died out and were replaced by an influx of modern human populations migrating into the continent, for example. In Australasia, this would mean the extinction of the archaic populations represented by the fossils at Sangiran and Ngandong as fully modern people migrated into the area. This model also posits that there was *very* little or no exchange of genes between the late-surviving Ngandong people and these modern immigrants.

There has been a great deal of evidence to support replacement hypotheses in the Australasian fossil record. Aziz and colleagues (1996; Baba *et al.*, 1998, 2000) reconstructed the face of Sangiran 17 and failed to find support for the earlier conclusions of Thorne and Wolpoff (1981) regarding regional continuity with early Australians. Studies by Brown (1981, 1989), Antón and Weinstein (1999), and Durband (2008b, c) have pointed out the presence of artificial cranial deformation in some Pleistocene Australians, calling into question the utility of certain features like flat frontal bones as indicators of continuity with Indonesian *H. erectus*. WLH 50 has also had its alleged transitional nature assailed in work by Neves *et al.* (1999), Stringer (1998), and Bräuer *et al.* (2004), and has even been suggested to be pathological (Webb, 1989, 1990). WLH 50 has also been recently redated to approximately 14,000 years by Simpson and Grün (1998), a date that may make the specimen too young to serve as an intermediary between the Ngandong fossils and modern Australians. Likewise, Ngandong has been redated by Swisher *et al.* (1996) to be as recent as 27,000 years. This surprisingly recent date would negate these specimens as potential ancestors to the Australians.

With this in mind, this paper will be focused upon the body of work surrounding this question of continuity vs. replacement in the human fossil sample from Indonesia and Australia. The scholarship surrounding the peopling of Australia is varied and complex. While I cannot hope to present a complete picture of this dynamic research in a short review, I do hope that the following paper will allow the reader to become familiar with the background and history of this work. These sections will be specifically focused on the arguments surrounding the topic of regional continuity that have so long been a part of paleoanthropological inquiry in this part of the world.

Interpretations of the Indonesian fossil record

Of course, any history of the interpretations surrounding the Indonesian hominids must begin with the opinions of Eugene Dubois, the man who discovered the first Pleistocene human fossils from the region. As is well known, Dubois (1935, 1936, 1937a, b, 1938a, b, 1940a, b, c) felt that his famous specimens from Trinil represented a true human ancestor while other fossils from Sangiran and Zhoukoudian in China were too derived to have been ancestral to later humans. His theories, however, were widely misunderstood at the time because Dubois

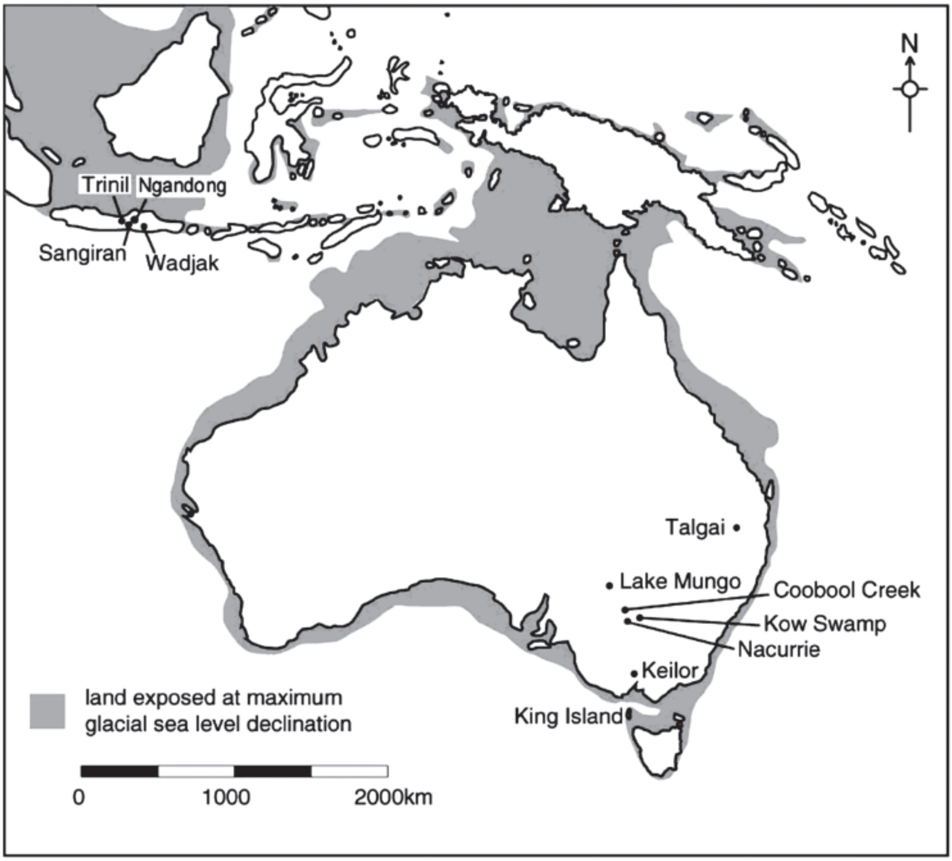

Fig. 1 - Map of relevant sites in Indonesia and Australia. Modified from a map created by Peter Brown.

insisted on emphasizing the human characteristics of the fossil assemblages from Ngandong, Zhoukoudian, and Sangiran while seemingly denigrating his own find by interpreting it as a giant gibbon (Dubois, 1935, 1937a, b, 1940a, b, c). This somewhat bizarre reading of the evidence was roundly chastised by scientists of the time (e.g. Le Gros Clark, 1937; Weidenreich, 1951) and generally dismissed by the scientific community as a whole. Only decades later, through the efforts of Theunissen (1989) and later Shipman (2001) were Dubois' motives for this stance made clear. They involved his work on the evolution of the brain, which he undertook in the years following his discoveries at Trinil (Theunissen, 1989). As a result of his experiments, Dubois (1923, 1924, 1928) formulated a hypothesis that the brain evolved through a series of spontaneous doublings in size from one species to another. While his *Pithecanthropus* had a brain too large to have given rise to modern humans through simple doubling, by assuming that *Pithecanthropus* had body proportions similar to that of a gibbon Dubois was able to manipulate the formula to make it work in terms of relative body size (Dubois, 1935; Theunissen, 1989). Thus, *Pithecanthropus* had double the encephalization of a modern gibbon and half that of a modern human, and was therefore the true human ancestor (Dubois, 1935, 1937b). On the other hand, none of the other purported human ancestors from China or Java could truly be ancestral to later humans because their brains were too large to evolve into a modern form through Dubois' proposed mechanism (Dubois, 1938b, 1940a, b, c; Theunissen, 1989).

Though interesting as a historical footnote, Dubois' interpretations lend little of substance to scholars in their search for relationships between the fossil humans from Java. Other individuals responsible for many of the important finds pre-dating the Second World War, however, provided more lasting contributions. In particular, Oppenoorth, Weidenreich, and von Koenigswald exploited comparative studies with the limited fossil sample available at the time in an effort to elucidate the position of Java man in the human phylogeny. Oppenoorth (1937) opined that Ngandong shares a number of similarities with Rhodesian man. After extensive comparison with Neandertals, Oppenoorth (1937: 352) states that similarities between the Ngandong fossils and European Neandertals "are more seeming than real as far as proof of identity." Instead, details of the supraorbital region and particularly the occiput were thought to ally Ngandong much more closely with the Broken Hill skull and placed them as the oldest known representatives of "*Homo sapiens fossillis*" (Oppenoorth, 1937). According to Weidenreich (1951), however, the views expressed by Oppenoorth (1937) represent a considerable change from an earlier stance (Oppenoorth, 1932a, 1932b, 1932c) that Ngandong represented a Neandertal type. This about face was likely due to the influence of Dubois, who, as mentioned earlier, was vehemently opposed to the idea that any of the fossils from Sangiran or Ngandong represented anything but ancient *Homo sapiens* (Weidenreich, 1951).

An alternative viewpoint held that the Chinese and Indonesian fossil material that had been recovered to that point (minus the Wajak fossils and the Upper Cave material from Zhoukoudian) represented a single species, *Homo (Pithecanthropus) erectus*. This idea was first suggested by von Koenigswald and Weidenreich (1939) regarding the material from Sangiran and Zhoukoudian, and later work (Weidenreich, 1943, 1951) also included the Ngandong hominids in this grouping. While he used many different names, such as *Sinanthropus* and *Pithecanthropus*, to refer to these various fossil specimens, Weidenreich (1951: 227) explained that he used these names only to "assign a given hominid specimen to a place in the phylogenetic morphological sequence" and that he did not consider them taxonomic designations in the strict sense. In fact, the Chinese and Indonesian forms were identical in 57 out of 74 character states that could be examined, and the two samples differed in only four characters according to a summary by Weidenreich (1943).

Weidenreich (1943, 1945b) found that Sangiran 2 represented the same type of hominid as the Trinil skullcap, despite the previously mentioned objections by Dubois (1936, 1937b, 1938b). Sangiran 3 was diagnosed as a juvenile, but nonetheless exhibited characteristics typical of Trinil and Sangiran 2 (Weidenreich, 1943, 1945b). Sangiran 4, on the other hand, was more difficult to interpret due to its larger size as well as the retention of some more primitive characteristics, such as a maxillary diastema (Weidenreich, 1943). Weidenreich (1943, 1945a, b, 1946) felt that Sangiran 4 might represent a link between more robust older forms, represented by the massive Sangiran 6 mandibular fragment, and the more lightly built *Pithecanthropus* skulls. Or, sexual dimorphism might also be invoked to explain the diversity in size and robusticity seen at Sangiran (Weidenreich, 1943). The Ngandong hominids were seen as "an enlarged *Pithecanthropus* type on the way to an advanced form" (Weidenreich, 1943: 274). Weidenreich (1943) regarded the Solo specimens as more primitive than the Neandertals and morphologically very similar to the preceding pithecanthropines, yet somewhat closer to modern humans. It was on this basis that he made his famous pronouncement that "[t]here is an almost continuous line leading from *Pithecanthropus* through *Homo soloensis* and fossil Australian forms to certain modern primitive Australian types" (Weidenreich, 1943: 276). As mentioned earlier, this assertion reverberates to the present day.

GHR von Koenigswald (1956) generally agreed with Weidenreich in his interpretation of the growing Javan fossil sample, but differed on a few key points and taxonomic designations. Koenigswald (1956) erected the species *Pithecanthropus modjokertensis* after discovery of the Modjokerto child in 1936, and placed Sangiran 4 in that species as an adult example. In his opinion the Sangiran 1 jaw, which was larger and more robust than the other pithecanthropines discovered to date, also belonged with this species and felt that this assemblage likely represented a robust ancestor of *P. erectus* (Koenigswald, 1956). Weidenreich (1943, 1945a, 1946) agreed in principle with this interpretation, but placed Sangiran 4 under a different species name, *Pithecanthropus robustus*, which would lead to some confusion in later publications. Koenigswald (1956) also differed with Weidenreich (1943, 1951) in considering the Ngandong fossils to be a tropical Neandertal. This view presupposes a worldwide "Neandertal phase" of hominid development prior to the development of more modern features. Koenigswald (1956) felt that the Ngandong specimens were too recent and advanced to represent a pithecanthropine and instead provided examples of this Neandertal phase on Java.

When large-scale excavations resumed on Java in the 1960's Indonesian scientists began publishing their own interpretations of the fossils, both new and old, and attempted to reconcile newer finds with previous ideas regarding the fossil sequence. Sartono (1964, 1967, 1968, 1971, 1972, 1975, 1990) was one of the more prolific Indonesian workers and participated in a number of fossil discoveries. His views of human evolution in Southeast Asia were very similar to Weidenreich's (1943, 1951) in that he perceived a lineal progression from Javan *Pithecanthropus* to later modern humans in Australia (Sartono, 1975). The discovery of Sangiran 17 (which he referred to as *Pithecanthropus* VIII) in 1969 yielded the most complete cranium recovered to date, and it also had a relatively large cranial capacity. This skull provided valuable new insight into the level of variation present at Sangiran. Sartono (1975) envisioned two different scenarios to explain the progression of forms on the island. The more speciose hypothesis contained five different species or subspecies (*Meganthropus, P. dubius, P. modjokertensis, P. erectus,* and *P. soloensis*) while his preferred model utilized two subspecies, a small-brained group and a large-brained group (Sartono, 1975). The large-brained group was considered chronologically younger and more advanced, and contained the Zhoukoudian skulls, Sangiran 17 (*Pithecanthropus* VIII), and the Ngandong crania. Sartono (1975) posited that the small-brained group evolved into the large-brained group, and that Sangiran 12 (*Pithecanthropus* VII) could have served as an intermediate form between the two groups.

Jacob (1969, 1972a, b, 1975, 1976, 1978a, b, 1979, 1981, 1984, 2001) has also written extensively on the Indonesian hominid sample. He has argued convincingly that the Sangiran and Ngandong crania were probably not victims of cannibalism (Jacob, 1969, 1972b, 1978a, 1981) and also corrected what he perceived as errors by Weidenreich (1951) in his descriptions of the Solo fossils (Jacob, 1969, 1978a). Like Sartono, Jacob has identified a number of different groups in the Javan fossil assemblage. These groups include robust and gracile lines, with the robust group including *P. modjokertensis* (represented by the child's skull and Sangiran 4) and *P. soloensis* (Ngandong, Sambungmacan 1, and Sangiran 17), and the gracile group inhabited by *P. erectus* (the remaining Trinil and Sangiran specimens) (Jacob, 1975, 1978b, 1979, 1984). The robust group appears during the early Pleistocene and survives until the end of that period, while the gracile group is known only from the middle Pleistocene (Jacob, 1975, 1979). Jacob (1975, 1976, 1978a, b, 1979) suggests that *P. modjokertensis* evolved into *P. soloensis* during the middle or late Pleistocene, and that the latter species is differentiated by a number of unique features on the cranial base. *P. erectus* also evolved from *P. modjokertensis*, and "in turn evolved into late progressive pithecanthropines and early primitive *Homo* whose remains have not yet been discovered" (Jacob, 1979: 9). *P. soloensis* may also have evolved into *Homo* and contributed genes to later *H. sapiens* in the region (Jacob, 1976).

Santa Luca (1980) included most of the important fossils from Java in his oft-cited analysis of the Ngandong crania. Through his study of the craniometrics of this group he identified several characteristics of this sequence that he found noteworthy. For example, Santa Luca (1977, 1980) differed from Sartono (1975) in that he found the Trinil and Sangiran 2 calvaria probably represented the most primitive forms on the island while Sangiran 4 is actually more advanced morphologically. In his opinion it was more likely that Sangiran 17 was closely related to Trinil/Sangiran 2 while the Ngandong crania might have evolved from an ancestor similar to Sangiran 4 (Santa Luca, 1977, 1980). Santa Luca (1977, 1980) also discounted Jacob's (1975, 1976, 1979) placement of Sangiran 17 and the Sambungmacan 1 cranium into a *Pithecanthropus soloensis* group with the Ngandong skulls.

During the mid-1980s the Javan finds played a role in a growing debate over the validity of the species *H. erectus*. While these arguments could be seen as somewhat tangential to the focus of this paper, they are worth mentioning at least briefly because this viewpoint reflects a feeling among many workers that the Asian representatives of *H. erectus* represent a derived form that cannot be ancestral to modern humans. If this hypothesis is confirmed, and a split along geographical lines is supported, this would obviously impact any scenario for regional continuity in Australasia. A number of authors, including Stringer (1984), Andrews (1984), and Wood (1984, 1991) proposed splitting the African and Asian specimens that were currently subsumed under *H. erectus* into two species. The Asian specimens would retain that designation, while the African fossils, which lacked certain autapomorphies deemed peculiar to the Asian forms, would be placed in *Homo ergaster* (Andrews, 1984; Stringer, 1984; Wood, 1984). This hypothesis was countered by a number of studies which pronounced that the so-called autapomorphies were not only variable within the African and Asian samples but could also be found on non-erectine specimens (e.g. Rightmire, 1990; Kennedy, 1991; Bräuer and Mbua, 1992). Work with the hominids from Dmanisi has underscored the difficulties in separating the *H. erectus* sample into regional groupings (e.g. Vekua *et al.*, 2002; Lordkipanidze *et al.*, 2006; Rightmire *et al.*, 2006). Other recent studies (e.g. Kidder & Durband, 2004; Baab, 2008) have likewise generated little support for splitting the African and Asian specimens of *H. erectus*. A considerably more conservative approach to this problem has been taken by Wolpoff and colleagues (1994). They have called for the sinking of *H. erectus* altogether, claiming that the evidence for regional continuity is so convincing that these specimens should instead be re-classified as early *Homo sapiens* (Wolpoff *et al.*, 1994). This solution has not received much support in the field.

Rightmire (1984, 1990, 1992, 1994) is one of the leading skeptics of this extreme lumping viewpoint. He asserts that *Homo erectus* is clearly a diagnosable taxon separate from later *H. sapiens* (Rightmire, 1992), and also feels that splitting the sample into two or more species is unwarranted (Rightmire, 1984, 1990). In fact, Rightmire (1981, 1990) contends that there is little evidence for significant change over the lifetime of the species. In particular, a very weak trend for increasing brain size indicates that *Homo erectus* (including Ngandong) was not evolving in the direction of modern humans and was likely replaced by more advanced hominids in the middle Pleistocene (Rightmire, 2004). Rightmire (1990) does not see any justification for more than one species of *Homo* in the Pleistocene of Java. He feels that the specimens share a number of similarities, and any differences in size can probably be explained by sexual dimorphism (Rightmire, 1990). Even the Ngandong hominids show a typical *Homo erectus* pattern that is not transitional in form (Rightmire, 1994).

Another significant debate that took shape during the 1980's and early 1990's was the modern debate over the origins of modern humans. While rooted in the works of scholars like Weidenreich (1943, 1951), more recent workers like Wolpoff (1989, 1992; Wolpoff *et al*; 1984) and Thorne (1971, 1976, 1977, 1980, 1989; Thorne & Wolpoff, 1981) shaped the formation of the modern Multiregional hypothesis. The Indonesian material from Sangiran and Ngandong featured significantly in this model, perhaps most prominently in the comparisons between the faces of Sangiran 17 and the Pleistocene Australians from Kow Swamp (Thorne and Wolpoff, 1981). Based on a list of features that were shared between the ancient Indonesians and Pleistocene Australians, they concluded that these samples showed a significant amount of genetic continuity had persisted in the Australasian region, potentially spanning over a million years. These ideas were expanded in later studies like those of Frayer and colleagues (1993), who found that the uncertainly dated WLH 50 specimen shared 12 cranial features with the Ngandong fossils, while not one feature exclusively linked WLH 50 with Ngaloba, a middle Pleistocene African cranium. This work has been supported by subsequent research (e.g. Hawks *et al.*, 2000; Wolpoff *et al.*, 2001).

Kramer (1989, 1991, 1993) has also contributed to this debate. Like Rightmire, Kramer (1993) also supports a single-species scenario for the cranial specimens allocated to *H. erectus*, and does not see any justification for splitting the sample geographically. He also found that a modern Australian mandibular sample shared a number of non-metric similarities with the Sangiran mandibles, and that those samples both differed considerably from a robust modern African sample (Kramer, 1989, 1991). This work is rare in that a non-cranial element has been used to demonstrate regional continuity, and provides independent support for claims of continuity derived from cranial features (e.g. Thorne & Wolpoff, 1981; Frayer *et al.*, 1993).

Other recent contributions to this debate include work by Antón (2001, 2002, 2003; Antón *et al.*, 2002), Kidder & Durband (2000, 2004), and Durband (2002, 2004a, b, 2007). These studies show general homogeneity in the overall cranial shape in the Indonesian sample, and provide support for a single anagenetic lineage of hominids in that region. Work with the non-metrics of these Southeast Asian hominids, however, may indicate that a speciation event occurred on Java in the late Pleistocene. Durband (2002, 2004a, b, 2007, 2008d) has identified a number of potential autapomorphies on the cranial bases of the Ngandong, Sambungmacan, and Ngawi samples that appear to indicate evolution beyond the condition seen in the Sangiran hominids. These features are also not found in any modern human samples examined to date, which would suggest that that the Ngandong fossils represent a population that went extinct after a period of differentiation from earlier hominids found on the island (Durband 2002, 2004a, b, 2007, 2008d; Baba *et al.*, 2003). This possibility will be discussed in more detail later in the paper.

Interpretations of the Australian fossil record

There has been considerable debate during the past 50 years surrounding the composition of the first permanent human groups to reach Australia. The earliest theories, from workers like Birdsell (1949, 1950, 1967) and Morrison (1967), sought to explain the variation present in living populations of Aboriginals though the genetic contributions of multiple founding populations. This initial work profoundly influenced the history of this debate into the late 20th century and surely contributed to later attempts to explain the variation seen in skeletal remains of Pleistocene inhabitants though a population hybridization model (Thorne, 1971, 1976, 1977, 1981, 1984, 1989; Thorne & Wilson, 1977; Thorne and Wolpoff, 1981; Webb, 2006).

Of these early theories, Birdsell's (1949, 1967) trihybrid model was clearly the most influential. While many early authors, including Keith (1925) and Jones (1934) maintained that the Australian Aboriginals represented a homogenous population, Birdsell (1967) criticized this work on the basis that it was done only on cranial samples and did not incorporate any measurements or observations from living subjects. Birdsell (1949, 1967), on the other hand, formulated his theory of three successive waves of migrants after work involving anthropometric measurements, skin and eye pigmentation, hair color and type, dental morphology, and various blood groups. Using these characters, Birdsell (1949, 1967) hypothesized that there were three ancestral sources for the gene pool of modern Australians that arrived in successive waves of immigration. The first was the Oceanic Negrito, which was characterized by short stature, dark skin, woolly hair form, and a short narrow face (Birdsell, 1950). The second wave brought the Murrayian people, who were characterized by short stature, relatively light pigmentation, wavy to straight hair form, and a massive face with large brow ridges (Birdsell, 1950). Finally, the third major influx of genes was brought by the Carpentarians. This group was characterized by tall stature, very dark skin, wavy to straight hair form, and a high and narrow skull with large brows (Birdsell, 1950). The distribution of features in modern Australians could be explained through interactions between these groups. Birdsell (1949, 1950, 1967) found that much of the Negrito contribution to the gene pool had been swamped by the subsequent waves of invaders. Present day descendants of the Negritos had been marginalized to only a very small percentage of the landmass, while the Murrayians had settled in the southern part of the continent and the Carpentarians took the northern areas (Birdsell, 1967). Birdsell (1967) felt that the archaeological record of both Australia and mainland Asia supported this theory and provided evidence for each of his three types in the distant past. In fact, he categorized some of the known Pleistocene Australian skulls, calling Keilor "classic Murrayian in type" (Birdsell, 1967: 148) and also claimed that the Wajak 1 skull from Java represented this group. It is interesting to note that Birdsell (1967) also speculated that the more primitive traits seen in his Murrayian and Carpentarian types could potentially be attributed to genetic exchange with *Homo soloensis* or other archaic populations.

Another hybridization model for the origins of the indigenous Australians was put forth by Morrison (1967: 1056), who felt that the Aboriginals "are derived from at least two successive waves of immigrants, who were genetically dissimilar." He based his theory on a number of different genetic markers found in the blood, including ABO, MNS, Gc serum, Gm serum, Haptoglobins, and Transferrins (Morrison, 1967). These markers were found to show significant differences between those Australians who lived in the interior and those inhabiting the peripheral areas of the continent (Morrison, 1967). Certain genetic markers were restricted to the center of Australia, and Morrison (1967) felt that the best explanation for the lack of these markers in other areas was the presence of at least two founding populations.

A number of other researchers arrived at the more economical conclusion that the data do not warrant hybridization events and instead represent a single, morphologically variable founding population (Abbie, 1951, 1963, 1966; Howells 1973a, 1977; Larnach, 1974; Macintosh and Larnach, 1976). As Howells (1977) points out, before 1950 anthropologists were concerned mainly with the idea of "pure racial strains" and tended to approach problems of populational history through hybridization or migrations to explain variation. These obsolete ideas clearly influenced Birdsell (1949, 1967) and his theories of large-scale population amalgamations in Australia. Howells (1973a, b, 1977) found that the cranial samples from Australia were quite uniform and that there was no basis for subdividing the sample. Larnach (1974) likewise found the Australian sample to be fairly invariable and homogenous, and colorfully adds that "images of Negritos, Murrayians, and Carpentarians are ghost images which disappear as we trace them back towards Aboriginal beginnings" (213). Instead of wholesale movements of diverse "racial" stock, more complex interactions involving selection and adaptation to localized environments could be invoked to explain the diversity seen in the cranial, anthropometric, and serological data sets (Howells, 1977; Pardoe, 1991, 2003).

Just as the Birdsellian ideas regarding multiple founding stocks were falling from favor, however, a new brand of hybridization theory was proposed by Alan Thorne (1971, 1976, 1977, 1980, 1981, 1984, 1989; Thorne & Wilson, 1977). As a doctoral student Thorne took part in the excavations of both the Lake Mungo and Kow Swamp burials, and he was intrigued by the obvious differences between these sets of individuals. According to Thorne (1976: 105), "The Kow Swamp crania are large by more recent Aboriginal standards. They indicate a greater robusticity or ruggedness." By contrast, the Lake Mungo 1 individual "is lightly constructed and has weakly developed muscle insertion sites" and "is striking" in its differences with the Kow Swamp material (Thorne, 1976: 109). Likewise, the Lake Mungo 3 skeleton, which Thorne (1977) diagnosed as male, was classified as gracile in overall form. These two skeletal samples formed the basis for a new "robust" and "gracile" dichotomy proposed by Thorne (1971, 1976, 1977, 1980, 1981, 1984, 1989) to encompass what he felt was an extreme amount of variation in the Pleistocene fossil sample from Australia (Figures 2 and 3). Thorne later expanded his classifications to include other well-known fossils, placing Keilor, Green Gully, King Island, and Lake Tandou in the gracile group and specimens such as Cohuna, Cossack, Mossgiel, WLH 50, and the Coobool Creek sample in the robust group (Freedman & Lofgren, 1979; Habgood, 1986; Sim &Thorne, 1990; Thorne & Wolpoff, 1992). Work by Pietrusewsky (1979), Macintosh (1963, 1967a, b) and Freedman and Lofgren (1979) supported the notion that two differing morphologies were present in Australia during the Pleistocene.

As with Birdsell (1967), migration from elsewhere was invoked to explain these radically different morphologies. Thorne (1980: 40) suggested that the robust group had "the mark of ancient Java" while the gracile group bore the "stamp of ancient China," and thus both mainland Asia as well as insular Southeast Asia contributed to the modern Australian gene pool. Features such as a low sloping frontal, large brow ridges, facial prognathism, and thick cranial bone linked the Australian robust group with Indonesian *Homo erectus* specimens to their immediate north, particularly the Ngandong fossils (Thorne, 1977, 1980). Meanwhile, the predecessors of the gracile Australians could be found in the Upper Cave folk from Zhoukoudian and the Liujang cranium (Thorne, 1980). Examples of these gracile peoples could be found closer to Australia in the Niah Cave deep skull in Borneo, Tabon in the Philippines, and Wajak 1 in Java (Thorne, 1980). These ideas contributed substantially to the formation of the Multiregional Theory of modern human origins (Thorne & Wolpoff, 1981; Wolpoff, 1989, 1992, 1999; Wolpoff *et al.*, 1984), and continue to be espoused by Thorne (2002; Thorne & Sim, 1994; Thorne *et al.*, 1999; Thorne, personal communication) and others (Webb, 2006).

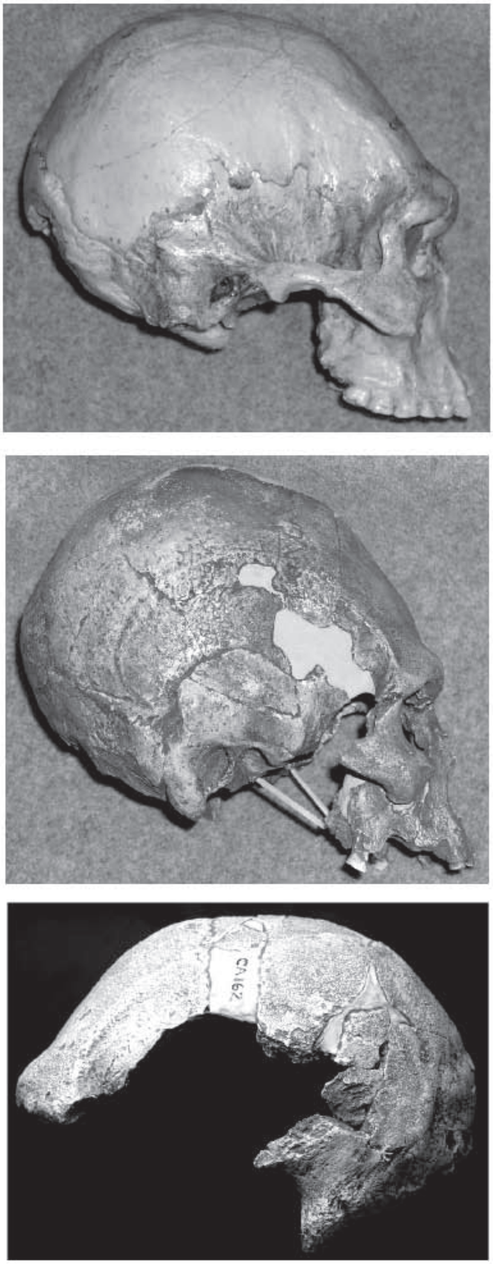

Fig. 2 - "Robust" Pleistocene Australian crania. From top to bottom: Cohuna, Kow Swamp 5 and WLH 50. All crania are casts. Note the flatter foreheads, larger brow ridges, and more heavily built features on these specimens.

Several workers, among them many Australian scholars, fail to find support for Thorne's dihybrid scenario. As stated earlier, both Howells (1973a, 1977) and Larnach (1974) found the Australian cranial samples to be homogenous, though they also found that Australians as a group retained an unusually high number of primitive characteristics. These plesiomorphies include thicker cranial bone, larger mean size, and greater development of some cranial superstructures like the occipital torus (Larnach, 1974). Multivariate work by Habgood (1986) also cast doubt on Thorne's robust vs. gracile dichotomy, finding that when compared to a world sample of late Pleistocene/early Holocene crania the Australian specimens clustered with one another and away from other groups. Pardoe (1991) concurred, and attributed the variation present in the Pleistocene Australian sample to simple sexual dimorphism. The most vociferous critic of Thorne's dihybrid vision has been Peter Brown (1981, 1987, 1989, 1992, 2000). Brown has questioned the legitimacy of Thorne's robust and gracile morphs on several fronts, including the accuracy of sex diagnoses (Brown, 1994, 1995, 2000; Brown & Gillespie, 2000), the confounding effects of cultural practices on cranial morphology (Brown, 1981, 1989), and the rationale behind the diagnosis of robustness itself (Brown, 1987, 1992, 2000; Brown & Gillespie, 2000). For example, Brown (1987, 1989, 1994) has criticized Thorne's (1977; Thorne & Wilson, 1977) diagnosis of the Keilor specimen as gracile despite its large size and general robusticity. Likewise, Brown (1994, 1995, 2000; Brown & Gillespie, 2002) takes issue with Thorne's (1980; Thorne *et al.*, 1999) assignment of male sex to the Lake Mungo 3 specimen, stating that

> *"[w]hile [Lake Mungo 3] is certainly tall and robustly built in comparison with late Holocene female Aborigines, outside the Holocene female range for some postcranial dimensions, this is not enough to indicate male status for a Pleistocene Australian. Supraorbital morphology, as well as frontal curvature and absence of a median frontal ridge, is decidedly feminine and contrasts with all of the Coobool Creek, Kow Swamp, and Nacurrie males." (Brown, 2000: 748)*

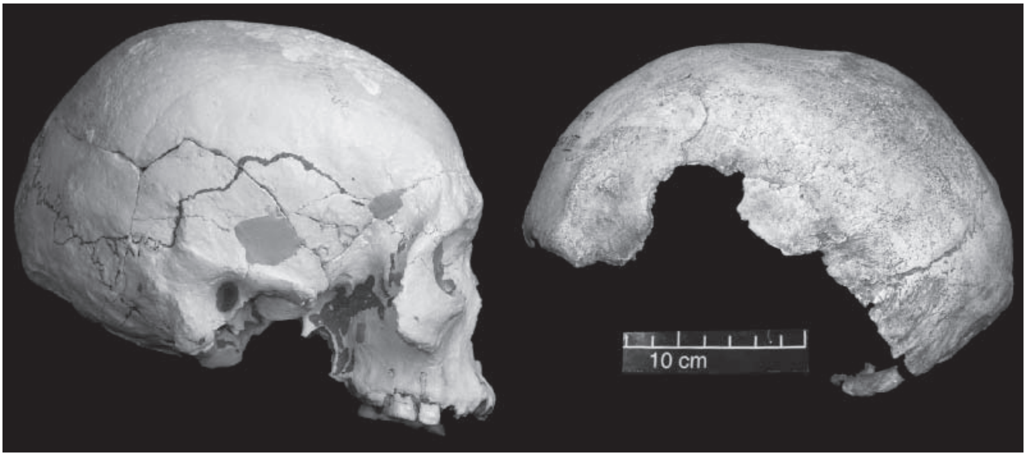

Fig. 3 - "Gracile" Pleistocene Australian crania. Keilor (left) and Lake Mungo 3 (right). Both specimens are casts. Note the more lightly built features with higher foreheads and smaller brows.

A lengthy debate was also waged over the sex of the King Island skeleton (Brown, 1994, 1995; Sim & Thorne, 1995; Thorne & Sim, 1994), which Brown felt had been too hastily categorized as male by Thorne despite several feminine characteristics. These battles highlight the fundamental concern with the dihybrid scenario in the minds of workers like Brown (1987, 1989) and Pardoe (1991): a lack of appreciation for variation in the Pleistocene and Holocene record of Australia. Brown (1987: 61) found that the "combination of the craniometric, tooth size and vault thickness results suggests a single, homogenous Pleistocene population" that shows "a consistent Australian Pleistocene morphology." Artificial cranial deformation practiced by the populations represented by Kow Swamp and Coobool Creek (Brown 1981, 1987, 1989; Antón & Weinstein, 1999; Durband 2008b, c) has also created the false appearance of more archaic cranial variation in several specimens from these samples. In short, all of the variation present in the Pleistocene Australian cranial sample could be accommodated in a single variable population exhibiting sexual dimorphism and cultural modification, and explanations requiring multiple founding populations were unsupported by the evidence.

While the single population explanation for the peopling of Australia would appear to be the most parsimonious, it must still be able to explain why the inhabitants of Australia become increasingly robust during the end of the Pleistocene. This observed increase in robusticity runs counter to the reduction in robusticity seen elsewhere in the world (Wolpoff, 1999) and has been difficult to explain without invoking immigrations of skeletally robust people (e.g., Thorne, 1977, 1980). Proponents of the single population theory argue that selection, and not hybridity, can explain the transition from a relatively gracile early Pleistocene sample to more robust late Pleistocene populations and then back to more delicately built modern groups. Brown (1987) feels that increased Holocene air temperatures on Australia might have influenced body proportions though a reduction in overall body size. This reduction could have affected cranial dimensions and tooth size and concurrently reduced prognathism as well. Bulbeck (2001) hypothesizes that increasingly harsh climatic conditions during the last glacial maximum on Australia could have led to an increase in robusticity like that seen at Kow Swamp, and that amelioration of those conditions would have allowed the reduction in robusticity seen into the Holocene.

This scenario would be consistent with the relative gracility seen in the early Lake Mungo skeletons, an increase in robusticity throughout the continent around 19-21 kyr, and then the subsequent reduction in robusticity expected in fully modern populations (Bulbeck, 2001; Stone and Cupper, 2003). Better understanding of the nature and timing of climatic changes in Australia during the late Pleistocene (e.g., Bowler *et al.*, 2003; Stone & Cupper, 2003) may help clarify the selective pressures at work in those populations. Finally, physical violence as a means of settling personal disputes may have also contributed to the increase in robusticity (Brown, 1987, 1989). A sample of 430 Australian crania from archaeological sites in New South Wales, Victoria, and South Australia showed cranial fractures in 37% of the males and 59% of the females (Brown, 1987). This level of interpersonal violence would have led to selective pressure for thicker and more robust cranial vaults (Brown, 1989). It is possible that cultural factors developed within the indigenous populations of Australia that caused a higher incidence of violence, and subsequently selected for greater robusticity, during the last glacial maximum. Higher population densities, competition for scarce resources, increased competition for access to mates, or any combination of these stressors could have led to an increase in violent encounters during this period.

On a final note, ancient DNA studies have also recently provided information germane to the question of the founding population(s) of Australia. Adcock and colleagues (2001) extracted mtDNA from a number of Australian Pleistocene fossil specimens, including Lake Mungo 3, and found no significant distinction between anatomically robust and gracile specimens. While the Lake Mungo 3 sequence was found to differ substantially from the other fossil and living Australians, suggesting a divergence of the Lake Mungo 3 sequence before the last common ancestor of contemporary human populations, the remainder of the fossil Australians tested formed a clade with living Australian aboriginal mtDNA sequences (Adcock *et al.*, 2001). These findings cast further doubt on a dihybrid explanation for Pleistocene Australian morphological variation (Adcock *et al.*, 2001; Relethford, 2001). However, see Smith and colleagues (2003) for an alternative view on the potential hazards of sequencing ancient DNA from Lake Mungo.

Discussion

A large and diverse body of scholarship has been developed for the fossil evidence discovered in Southeast Asia and Australia. This work has predominantly been focused on the possible relationships, or lack thereof, between these fossils and regional populations of modern humans. Despite its importance to many different aspects of paleoanthropological research, Australasia receives significantly less attention than it deserves.

Based on the available evidence, it would appear that hominids have occupied the region for at least 1.5 million years (Larick *et al.*, 2001). These earliest hominids, represented by fossils like Sangiran 4 and 27, were quite robust and retained a number of more primitive features like slightly projecting canines and diastemata (Wolpoff, 1999; Durband, 2008a). Java was only intermittently connected to the mainland of Asia during the next million years or so, allowing only limited faunal exchanges with the continent (de Vos *et al.*, 1982, 1994; de Vos 1987; Aziz *et al.*, 1995; Long *et al.*, 1996; van den Bergh *et al.*, 2001). Indeed, the Indonesian fossils from Sambungmacan and Ngandong exhibit a series of unique features that suggest a significant period of *in situ* evolution with little gene flow from outside the region (Durband, 2002, 2004a, b, 2007, 2008d; Baba *et al.*, 2003). It has been suggested that these late surviving archaic humans disappeared as part of a wider faunal turnover that took place around 126 kyr as Java became wetter and more tropical (Storm, 2000, 2001a, b), though other possible fates for these hominids have been proposed (e.g. Thorne 1980; Webb, 2006), as discussed above.

The Australian continent was first inhabited around 45 kyr, though claims for earlier occupations persist (see O'Connell & Allen, 2004). The earliest skeletal evidence comes from the southeastern corner of the continent at the site of Lake Mungo, dated most securely to 40 ± 2 kyr (Bowler *et al.*, 2003; though see Thorne *et al.*, 1999). Lake Mungo 3 has been diagnosed as male (Bowler & Thorne, 1976; Thorne, 1977; Durband *et al.*, 2006, in press; though see Brown, 2000) and has been described as having a very "gracile" cranium (Thorne, 1977). This gracility contrasts markedly with more "robust" crania from sites such as Kow Swamp, Cohuna, and Coobool Creek, and has led to the hypothesis that multiple founding populations contributed to the early peopling of Australia (e.g. Thorne, 1976, 1977, 1989; Webb, 2006). Archaic hominids from Java, such as the Sangiran and Ngandong fossils, potentially represent ancestral populations for the "robust" Australians, while the "gracile" groups are thought to have migrated from East Asia (Thorne, 1971, 1976, 1977, 1980, 1981, 1984, 1989). Other workers have explained the differences between these skeletons in terms of sexual dimorphism or other normal variation (e.g.; Brown, 1987, 1989, 1994a; Pardoe, 1991), variations in climate influencing skeletal robusticity (e.g., Brown, 1987; Bulbeck, 2001), physical violence leading to selection for thicker and more robust cranial vaults (e.g. Brown, 1987, 1989), or even cultural modification of the skull through intentional deformation (Brothwell, 1975; Brown, 1989; Antón & Weinstein, 1999; Durband, 2008b, c).

Based on my own reading of the data, I do not think that a strong case can be made for regional continuity using the fossil records from Indonesia and Australia. There are several lines of evidence that contribute to this opinion. One difficulty is the lack of a suitable transitional sequence between the late Indonesian fossils and earliest Australians. The earliest known Australians, represented by Lake Mungo 1 and 3, are "gracile" in their crania and lack heavy brow ridges and other cranial superstructures. These specimens contrast markedly with the anatomy of fossils from Sangiran and Ngandong, which all display thick brow ridges, angular and occipital tori, and other features not found in the earliest Australians. Thorne (1980) suggests that the ancestors to these earlier "gracile" specimens may come from China, but this has not been supported by metric studies on the more complete specimens like Keilor (e.g. Wu, 1987). Webb (2006) contends that it is possible that a robust population similar to the Ngandong people could have reached Australia as early as 160 kyr, but there is no archaeological (or morphological) evidence to support this.

While more recent specimens from sites such as Kow Swamp and Cohuna are thought to compare much more favorably to the Indonesian fossils, these relationships are likewise problematic. Many comparisons rely on very little evidence. For example, Sangiran 17 has the only facial skeleton preserved from the Pleistocene of Java, yet this single specimen has served as a lynchpin of the argument for regional continuity (e.g. Thorne & Wolpoff, 1981; Wolpoff, 1999). Thorne & Wolpoff (1981), relying on one reconstruction of Sangiran 17, noted a number of facial similarities between that specimen and the Kow Swamp fossils. However, a newer reconstruction of the Sangiran 17 face by Aziz and colleagues (1996; Baba *et al.*, 1998, 2000) has cast doubt on each of those perceived similarities. Other studies have cited features such as a low frontal bone and prominent brow ridges as evidence for regional continuity between some Australian fossils and earlier Indonesians (e.g. Curnoe, 2007 as one recent example), but there is ample evidence that these features have likely been manipulated in some Pleistocene Australian specimens through artificial deformation. In general, the specimens that have received much of the attention from regional continuity advocates, such as Kow Swamp 1, Kow Swamp 5, and Cohuna, have likewise shown some of the best evidence for cultural modification of the frontal bone (e.g.; Brothwell, 1975; Antón & Weinstein, 1999; Durband, 2008c). While it is certainly true that claims of artificial deformation cannot be supported for all early Australian crania, the fact that the specimens most often noted for their archaic looking fronto-facial morphology (like Kow Swamp 1 and 5, Cohuna, and many of the Coobool Creek specimens) share such close shape similarities with known deformed individuals (e.g. Antón & Weinstein, 1999; Durband, 2008b, c) is surely cause for some concern. Even if claims for artificial deformation are discounted, many perceived similarities between the so-called "robust" Australians and the Ngandong fossils are problematic. Webb (1989) has pointed out distinct differences in brow ridge form between early Australians such as WLH 50 and the Ngandong fossils. While the "robust" Australians such as WLH 50 and Kow Swamp have brow ridges that are thickest medially and thinnest laterally, the Ngandong fossils are thinner medially and thickest laterally at the supraorbital trigone (Webb, 1989). None of the "robust" early Australians have a lateral supraorbital trigone similar in size or shape to the Ngandong fossils (Figure 4).

Along with Sangiran 17, WLH 50 has received a great deal of attention as a potential transitional specimen linking the late surviving Ngandong fossils with "robust" modern Australians (e.g. Wolpoff, 1999; Hawks *et al.*, 2000; Wolpoff *et al.*, 2001). WLH 50 is an exceptionally robust calvarium discovered in 1982 that still remains undescribed despite its apparent significance. Several recent studies have examined this specimen in regards to its importance for modern human

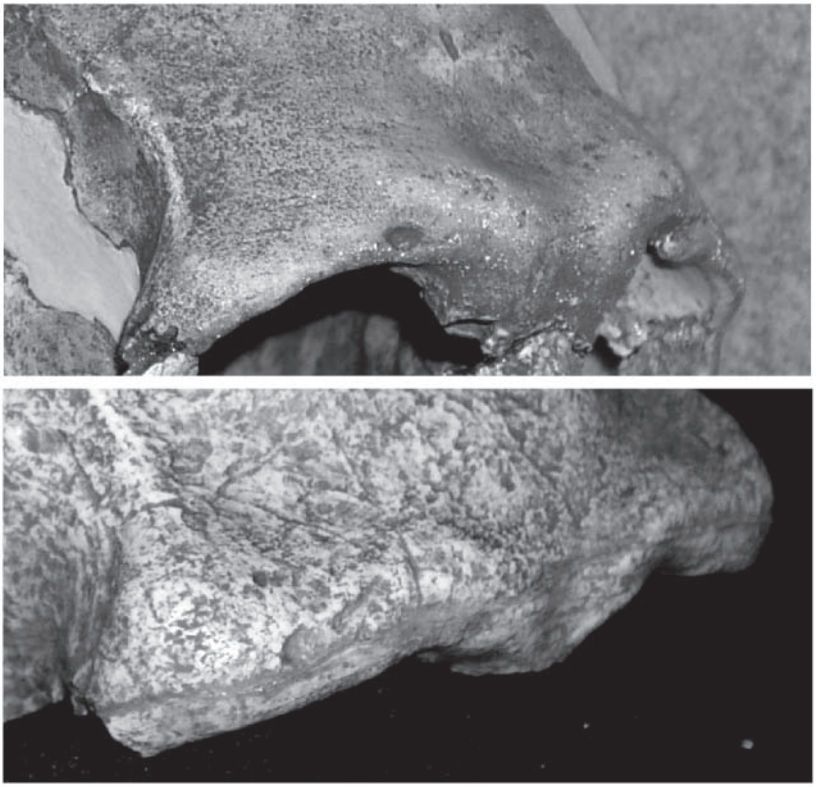

Fig. 4 - Comparison between the brow ridges of Kow Swamp 5 (top) and Ngandong 12 (Solo XI) (bottom). Both specimens are casts. Note how the brow ridges of Kow Swamp 5 are thickest medially near glabella, while the Ngandong brow is thinnest medially and thickest laterally at the lateral knob-like trigone. The Kow Swamp brows are also more curved over each orbit, while the Ngandong brow is straighter and more bar-like.

origins (e.g. Stringer, 1998; Hawks *et al.*, 2000; Wolpoff *et al.*, 2001; Bräuer *et al.*, 2004; Webb, 2006). At best, WLH 50 is an enigmatic and somewhat problematic specimen for this debate. Simpson & Grün (1998) have dated this specimen to only 14 kyr, which is considerably younger than other ancient Australians like the Lake Mungo remains. It has also been rather persuasively argued to be pathological by Webb (1989, 1990, 1995), and at the very least this pathology has significantly increased this individual's cranial vault thickness. Webb (2006: 198) has more recently tempered this viewpoint, stating that "[i]t is clear that WLH50 is a very robust individual with or without pathology, because other heavily developed features are clearly not pathological." While this is almost certainly true, it is impossible to discern to any reliable degree just what WLH 50's morphology would be like without this pathology. WLH 50 is clearly at the very top end, or well in excess, of the range of variation for the Willandra Lakes crania (e.g. Webb, 1989), and thus it would be difficult to argue that it is in any way representative of a typical Pleistocene Australian. While a few other Australian specimens may match the linear dimensions of WLH 50 (e.g. Hawks *et al.*, 2000), one must wonder why those crania have not received similar notoriety as important transitional fossils. As mentioned above, the pattern of supraorbital thickness in WLH 50 is not similar to the pattern in the Ngandong fossils (Webb, 1989), and the occipital region of WLH 50 does not have a strong, posteriorly projecting nuchal torus with a scooped or hollowed inferior edge and an inferiorly pointing triangle at inion as in the Ngandong crania (Figure 5). Bräuer and colleagues (2004) have pointed out other significant problems with recent projects (Hawks *et al.*, 2000; Wolpoff *et al.*, 2001) purporting to demonstrate WLH 50 as a transitional specimen sharing morphological affinities with ancient Indonesians.

Finally, several unique features have been identified on the cranial base of the Ngandong and Sambungmacan crania (Durband, 2002, 2004a, 2007, 2008d; Baba *et al.*, 2003). These features include a doubled foramen ovale (found in each of the Ngandong and Sambungmacan specimens that retain this structure), large rugose bulges flanking the posterior foramen magnum

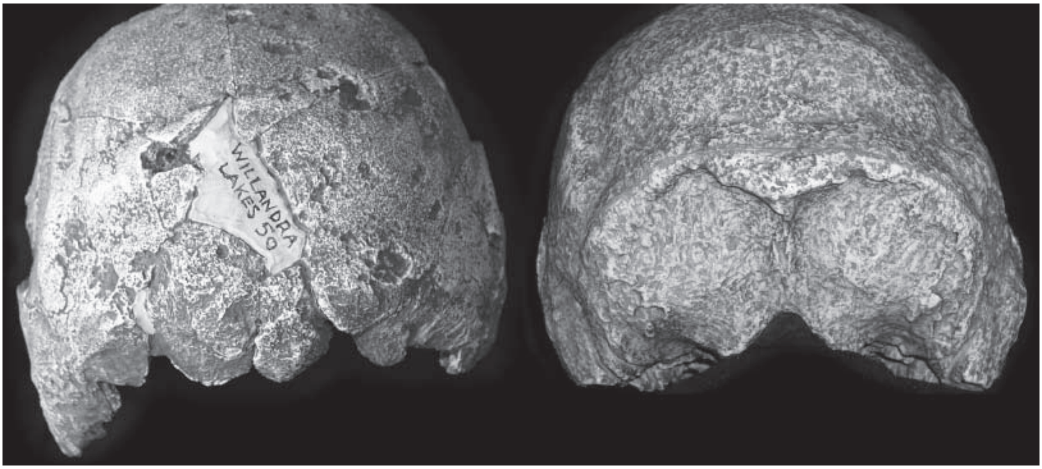

Fig. 5 - Comparison between the occipital regions of WLH 50 (left) and Ngandong 12 (Solo XI) (right). Both specimens are casts. The Ngandong specimen has a strongly developed nuchal torus that overhangs the nuchal plane, and an inferiorly pointing triangular process at inion. WLH 50 does not have a strongly projecting torus nor a triangularly shaped process at inion. While these crania are photographed at slightly different angles, the WLH 50 occipital clearly does not have the same form as in Ngandong.

known as postcondyloid tuberosities, an opisthionic recess (narrowing of the posterior foramen magnum), and the lack of a “true” postglenoid process coupled with a squamotympanic fissure located wholly in the apex of the mandibular fossa along its entire length (Durband, 2002, 2004a, 2007, 2008d; Baba *et al.*, 2003). Many of these features have been noted by earlier authors (e.g. Weidenreich, 1951; Jacob, 1969), and the unique location of the squamotympanic fissure in the Ngandong fossils was even mentioned by Thorne and Wolpoff (1981: 341, note that they call it the Glaserian fissure). None of these features has been found outside of the Ngandong sample, and none of the fossil Australians have any of these traits (Durband, 2004a, 2007, 2008d). It is difficult to envision how a character like a flatter frontal or thicker brow ridge could be seen as an important link between the Ngandong sample and “robust” early Australians while other features seemingly limited to Ngandong, and thus more likely to provide evidence of a regional link if one exists, are generally ignored in papers examining regional continuity in Australasia. Thorne (1975) does mention several of these Ngandong features in his dissertation, which is still the most comprehensive publication on the Lake Mungo 1 and Kow Swamp remains, but he simply points out that traits like a doubled foramen ovale and a squamotympanic fissure located in the apex of the mandibular fossa are *absent* in those Australian groups. This series of morphological incongruities between the Ngandong cranial bases and early Australians is difficult to reconcile with notions of regional continuity.

While the preceding litany of evidence supports a replacement model for modern human origins in Australasia, at least in my opinion, there may still be data that support at least some degree of regional continuity. For example, the studies on the Sangiran mandibles by Kramer (1989, 1991) have not been challenged. That work highlighted a series of potential regional characteristics that linked the Sangiran *H. erectus* mandibles with a modern Australian sample to the exclusion of a robustly built modern African sample. Of course, a replacement model would predict that the modern Africans and Australians would share a high number of features to the exclusion of the ancient Javans. Thus, genetic continuity between the Sangiran hominids and modern Australians is supported by Kramer’s (1989, 1991) work. One question that has interested me about this study is the effect that adding fossil Australian samples to this sequence may have. During the mid to late 1980’s when this work was done the political situation surrounding the remains of those early Australians became quite heated and it was difficult to work on them. Thus, it is not surprising that they were not made a part of the project. Subsequent work by the current author on some fossil Australian mandibles has highlighted some potential questions about how those fossils may or may not fit into the pattern of regional continuity (Durband, unpublished data). Unfortunately, interobserver error is almost certainly a problem for my data. Kaifu (2006) found that posterior tooth size at Sangiran had already become reduced relative to early Australians, and claimed that this fact made it unlikely that the Sangiran dental assemblage represents an ancestor of those ancient Australians. While this data may be somewhat problematic for Kramer’s (1989, 1991) conclusions, they also do not directly contradict them. Thus, a reevaluation of Kramer’s (1989, 1991) work remains an interesting project for future research.

Another intriguing question involves both the patterns and causes of increased robusticity in late Pleistocene and early Holocene Australian populations. As mentioned previously, this trend for increased robusticity in early Australians is in opposition to the observed tendency for decreasing robusticity elsewhere in the world (e.g. Wolpoff, 1999). Brown (1989) has suggested the possibility that high levels of cranial trauma caused by interpersonal violence led to selection for thicker cranial vaults. As there appears to be little difference between the postcrania of so-called “gracile” and “robust” Australian males (e.g. Durband *et al.*, 2006, in press) it is quite possible that some form of selection involving only the cranium is responsible for these apparent differences in robusticity. Other hypotheses posit an increasingly harsh climate during the last glacial maximum as a potential agent for increasing robusticity in early Australians (e.g. Brown, 1987; Bulbeck, 2001; Stone & Cupper, 2003). As our understanding of the paleoclimate and environment of Australia during the Pleistocene improves, we will learn more about its possible effects on the morphology of these early populations. Is it possible that some influence from robust Indonesian populations has contributed to increased robusticity in early Australians? It is, of course, possible. I would suggest that there is one particular difficulty (in my mind, anyway) that any hypothesis of regional continuity must address. If we remove the Ngandong hominids from the ancestry of the first Australians, which I think the evidence cited above would strongly support, we then have the problem of bridging the morphological and temporal gap between the Sangiran hominids and later Australians. Presently, without the Ngandong fossils there are no candidates to fill that gap. This does not mean that such a population does not exist, but if there is such a population it has yet to be discovered. As the evidence currently stands, the absence of such a population would certainly fit the predictions of a replacement model.

We are fortunate that Dubois chose to mount the first expedition meant to actively search for human fossils to Southeast Asia. His success at Trinil brought considerable and well-deserved attention to the fossil record of Australasia, and paved the way for the important work done by Weidenreich, von Koenigswald, Macintosh, Sartono, Jacob, Thorne, Brown, and many others on the assemblages recovered here. Through their efforts we have learned much about modern human origins in this fascinating corner of the world. Obviously, many questions remain unanswered and much work still awaits interested scientists. As research continues, using new technology and methods, we will add to the already considerable body of knowledge collected over the past century.

Acknowledgements

I would like to thank the Three Traditional Tribal Groups of the Willandra Lakes World Heritage area, the Mutthi Mutthi, Nyjampa, and Paakintji, for their permission to work on the Willandra Lakes skeletal collection. Teuku Jacob, Fachroel Aziz, Tony Djubiantono, Alan Thorne, Denise Donlon, John De Vos, and Friedemann Schrenk allowed me to study both original fossil specimens and casts in their collections. My work has benefited from discussions and assistance from many other colleagues, including Michael Westaway, Harvey Johnston, Daniel Rayner, Jim Bowler, Christine Hertler, Colin Groves, David Bulbeck, Marc Oxenham, Jim Kidder, Andrew Kramer, Fred Smith, Ann Macintosh, Etty Indriati, and Philip Habgood. Dorothy Durband and Bob Paine proofread this manuscript, and three anonymous referees likewise provided comments that improved this paper. This work was supported financially by Texas Tech University, The American Philosophical Society, Sigma Xi, The University of Tennessee, and Northern Illinois University.

Info on the web

http://www-personal.une.edu.au/~pbrown3/palaeo.html

Peter Brown's Australian and Asian Palaeoanthropology site – An excellent resource for anyone interested in the paleoanthropology of this fascinating region.

http://whc.unesco.org/pg.cfm?cid=31&id_site=167

UNESCO World Heritage listing for the Willandra Lakes.

References

Abbie A.A. 1951. The Australian Aboriginal. *Oceania*, 22: 91-100.

Abbie A.A. 1963. Physical characteristics of Australian Aborigines. In H. Shiels (ed): *Australian Aboriginal Studies*, pp. 89-107. Oxford University Press, Oxford.

Abbie A.A. 1966. Physical characteristics. In B.C. Cotton (ed): *Aboriginal Man in south and central Australia, Part 1*, pp. 9-45. Government Printers, Adelaide.

Adcock G.J., Dennis E.S., Easteal S., Huttley G.A., Jermiin L.S., Peacock W.J. & Thorne A. 2001. Mitochondrial DNA sequences in ancient Australians: Implications for modern human origins. *Proc. Natl. Acad. Sci. USA*, 98: 537-542.

Andrews P. 1984. An alternative interpretation of the characters used to define *Homo erectus*. *Courier Forschungsinstitut Senckenberg*, 69: 167-175.

Antón S.C. 2001. Cranial evolution in Asian *Homo erectus*: The Ngandong hominids. *Geological Research Development Centre Special Publication*, No. 27: 39-46.

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*. *Yearb. Phys. Anthropol.*, 37: 126-170.

Antón S.C., Marquez S. & Mowbray K. 2002. Sambungmacan 3 and cranial variation in Asian *Homo erectus*. *J. Hum. Evol.*, 43: 555-562.

Antón S.C. & Weinstein K.J. 1999. Artificial cranial deformation and fossil Australians revisited. *J. Hum. Evol.*, 36: 195-209.

Aziz F., Sondaar P.Y., de Vos J., van den Bergh G.D. & Sudijono 1995. Early dispersal of man on islands of the Indonesian archipelago: facts and controls. *Anthropol. Sci.*, 103: 349-368.

Aziz F., Baba H. & Watanabe N. 1996. Morphological study on the Javanese *Homo erectus* Sangiran 17 based upon the new reconstruction. *GRDC Paleontology Series*, No. 8: 11-25.

Baab K.L. 2008. The taxonomic implications of cranial shape variation in *Homo erectus*. *J. Hum. Evol.*, 54: 827-847.

Baba H., Aziz F. & Narasaki S. 1998. Restoration of head and face in Javanese *Homo erectus* Sangiran 17. *Bull. Natl. Sci. Mus., Tokyo, Series D*, 24: 1-8.

Baba H., Aziz F. & Narasaki S. 2000. Restoration of the face of Javanese *Homo erectus* Sangiran 17 and re-evaluation of regional continuity in Australasia. *Acta Anthropologica Sinica*, Volume 19 Supplement: 57-63.

Baba H., Aziz F., Kaifu Y., Suwa G., Kono R.T. & Jacob T. 2003. *Homo erectus* calvarium from the Pleistocene of Java. *Science*, 299: 1384-1388.

Birdsell J.B. 1949. The racial origin of the extinct Tasmanians. *Records of the Queen Victoria Museum*, 2: 105-122.

Birdsell J.B. 1950. Some Implications of the Genetical Concept of Race in Terms of Spatial Analysis. *Cold Spring Harb. Symp. Quant. Biol.*, 15: 259-314.

Birdsell J.B. 1967. Preliminary data on the trihybrid origin of the Australian Aborigines. *Archaeology and Physical Anthropology in Oceania*, 2: 100-155.

Bowler J.M., Johnston H., Olley J.M., Prescott J.R., Roberts R.G., Shawcross W. & Spooner N.A. 2003. New ages for human occupation and climatic change at Lake Mungo, Australia. *Nature*, 421: 837-840.

Bowler J.M. & Thorne A.G. 1976. Human remains from Lake Mungo: discovery and excavation of Lake Mungo III. In R.L. Kirk & A.G. Thorne (eds): *The Origin of the Australians*, pp. 127-138. Humanities Press, New Jersey.

Bräuer G., Collard M. & Stringer C. 2004. On the reliability of recent tests of the Out of Africa hypothesis for modern human origins. *Anat. Rec. Part A*, 279A: 701-707.

Bräuer G. & Mbua E. 1992. *Homo erectus* features used in cladistics and their variability in Asian and African hominids. *J. Hum. Evol.*, 22: 79-108.

Brothwell, D., 1975. Possible evidence of a cultural practice affecting head growth in some late Pleistocene east Asian and Australasian populations. *J. Archaeol. Sci.*, 2: 75-77.

Brown P. 1981. Artificial cranial deformation: A component in the variation in Pleistocene Australian Aboriginal crania. *Archaeology in Oceania*, 16:156-167.

Brown P. 1987 Pleistocene homogeneity and Holocene size reduction: the Australian human skeletal evidence. *Archaeology in Oceania,* 22: 41-71.

Brown P. 1989. *Coobool Creek. A morphological and metrical analysis of the crania, mandibles and dentitions of a prehistoric Australian human population. Terra Australis, 13.* Department of Prehistory, Australian National University, Canberra.

Brown P. 1992. Recent Human Evolution in East Asia and Australasia. *Philos. Trans. R. Soc. Lond., B, Biol. Sci.,* 337: 235-242.

Brown P. 1994. A flawed vision: sex and robusticity on King Island. *Australian Archaeology*, 38: 1-7.

Brown P. 1995. Still flawed: a reply to Pardoe (1994) and Sim and Thorne (1994). *Australian Archaeology*, 41: 26-29.

Brown P. 2000. Australian Pleistocene variation and the sex of Lake Mungo 3. *J. Hum. Evol.*, 38: 743-749.

Brown P. & Gillespie R. 2000. Mungo claims unsubstantiated. *Australasian Science*, 21: 26-27.

Bulbeck F.D. 2001. Robust and gracile Australian Pleistocene crania: The tale of the Willandra Lakes. In T. Simanjuntak, B. Prasetyo & R. Handini (eds): *Sangiran: Man, Culture and Environment in Pleistocene Times*, pp. 60-106. Yayasan Obor Indonesia, Jakarta.

Curnoe D. 2007. Modern human origins in Australasia: Testing the predictions of competing models. *Homo*, 58(2): 117-157.

de Vos J. 1987. The environment of *Homo erectus* from Trinil H.K. *Proceedings of the 2nd International Congress of Human Paleontology, Turin, Italy,* pp. 225-229.

de Vos J., Sartono S., Hardja-Sasmita S, & Sondaar P.Y. 1982. The fauna from Trinil, type locality of *Homo erectus*; a reinterpretation. *Geologie en Mijnbouw*, 61: 207-211.

de Vos J., Sondaar P.Y., van den Bergh G.D. & Aziz F. 1994. The *Homo* bearing deposits of Java and its ecological context. *Courier Forschungsinstitut Senckenberg*, 171: 129-140.

Dubois E. 1923. Phylogenetic and ontogenetic increase of the volume of the brain in vertebrata. *Proc. Koninklijke Nederlandse Akademie Wetenschappen*, 25: 230-255.

Dubois E. 1924. On the brain quantity of specialized genera of mammals. *Proc. Koninklijke Nederlandse Akademie Wetenschappen*, 27: 430-437.

Dubois E. 1928. The law of the necessary phylogenetic perfection of the psychoencephalon. *Proc. Koninklijke Nederlandse Akademie Wetenschappen*, 31: 304-314.

Dubois E. 1935. On the gibbon-like appearance of Pithecanthropus erectus. *Proc. Koninklijke Nederlandse Akademie Wetenschappen*, 38: 578-585.

Dubois E. 1936 Racial identity of *Homo soloensis* Oppenoorth (including *Homo modjokertensis* von Koenigswald) and *Sinanthropus pekinensis* Davidson Black. *Proc. Koninklijke Nederlandse Akademie Wetenschappen* 39: 1180-1185.

Dubois E. 1937a. Early Man In Java And Pithecanthropus Erectus. In G.G. MacCurdy (ed): *Early Man*, pp. 315-322. JB Lippincott Co., New York.

Dubois E. 1937b. On the fossil human skulls recently discovered in Java and Pithecanthropus erectus. *Man*, 37: 1-7.

Dubois E. 1938a. The mandible recently described and attributed to the Pithecanthropus by G.H.R von Koenigswald, compared with the mandible of Pithecanthropus erectus described in 1924 by Eug. Dubois. *Proc. Koninklijke Nederlandse Akademie Wetenschappen*, 41: 139-147.

Dubois E. 1938b. On the fossil human skull recently described and attributed to Pithecanthropus erectus by G.H.R. von Koenigswald. *Proc. Koninklijke Nederlandse Akademie Wetenschappen*, 41: 380-386.

Dubois E. 1940a. The fossil human remains discovered in Java by Dr. G.H.R. von Koenigswald and attributed by him to Pithecanthropus erectus, in reality remains of Homo wadjakensis (syn. *Homo soloensis*). *Proceedings of the*

Koninklijke Akademie van Wetenschappen, 43: 494-496.

Dubois E. 1940b. The fossil human remains discovered in Java by Dr. G.H.R. von Koenigswald and attributed by him to Pithecanthropus erectus, in reality remains of Homo wadjakensis (syn. Homo soloensis) (Continuation). *Proc. Koninklijke Nederlandse Akademie Wetenschappen*, 43: 842-851.

Dubois E. 1940c. The fossil human remains discovered in Java by Dr. G.H.R. von Koenigswald and attributed by him to Pithecanthropus erectus, in reality remains of Homo wadjakensis (syn. Homo soloensis) (Conclusion). *Proceedings of the Koninklijke Akademie van Wetenschappen*, 43: 1268-1275.

Durband A.C. 2002. The Squamotympanic Fissure in the Ngandong and Sambungmacan Hominids: A Reply to Delson et al. *Anat. Rec.*, 266: 138-141.

Durband A.C. 2004a. *A Test of the Multiregional Hypothesis of Modern Human Origins Using Basicranial Evidence from Indonesia and Australia.* Unpublished Ph.D. dissertation, University of Tennessee.

Durband A.C. 2004b. A test of the multiregional hypothesis of modern human origins using the basicranial evidence from Southeast Asia and Australia. *Am. J. Phys. Anthropol.*, Suppl. 38: 90-91.

Durband A.C. 2007. The View from Down Under: A Test of the Multiregional Hypothesis of Modern Human Origins using the Basicranial Evidence from Australasia. *Coll. Antropologicum*, 31: 651-659.

Durband A.C. 2008a. The enigma of the Sangiran 4 palate revisited. *Homo*, 59: 111-122.

Durband A.C. 2008b. Artificial cranial deformation in Pleistocene Australia: The Coobool Creek Sample. *J. Hum. Evol.*, 54: 795-813.

Durband A.C. 2008c. Artificial cranial deformation in Kow Swamp 1 and 5: a response to Curnoe (2007). *Homo*, 59: 261-269.

Durband A.C. 2008d. Mandibular fossa morphology in the Ngandong and Sambungmacan fossil hominids. *Anat. Rec.* 291: 1212-1220.

Durband A.C., Rayner D.R.T. & Westaway M. 2006. The sex of the Lake Mungo 3 skeleton. *Am. J. Phys. Anthropol.*, Suppl. 42: 85-86.

Durband A.C., Rayner D.R.T. & Westaway M. A new test of the sex of the Lake Mungo 3 skeleton. *Archaeology in Oceania,* in press.

Frayer D.W., Wolpoff M.H., Thorne A.G., Smith F.H. & Pope G.G. 1993. Theories of modern human origins: The paleontological test. *Am. Anthropol.*, 95: 14-50.

Freedman L. & Lofgren M. 1979. The Cossack skull and a dihybrid origin of the Australian Aborigines. *Nature*, 282: 298-300.

Habgood P.J. 1986. The origin of the Australians: a multivariate approach. *Archaeology in Oceania*, 21: 130-137.

Hawks J., Oh S., Hunley K., Dobson S., Cabana G., Dayalu P. & Wolpoff M.H. 2000. An Australasian test of the recent African origin theory using the WLH-50 calvarium. *J. Hum. Evol.*, 39: 1-22.

Howells W.W. 1973a. *Cranial Variation in Man.* Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 67, Harvard University, Cambridge.

Howells W.W. 1973b. *The Pacific Islanders*. Charles Scribner's Sons, New York.

Howells W.W. 1977. The Sources of Human Variation in Melanesia and Australia. In: J. Allen, J. Golson & R. Jones (eds): *Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melanesia, and Australia*, pp. 169-186. Academic Press, New York.

Jacob T. 1969. *Some problems pertaining to the racial history of the Indonesian Region*. Drukkerij Neerlandia, Utrecht.

Jacob T. 1972a. New hominid finds in Indonesia and their affinities. *Mankind*, 8: 176-181.

Jacob T. 1972b. The problem of head-hunting and brain-eating among Pleistocene men in Indonesia. *Archaeology and Physical Anthropology in Oceania*, 7: 81-91.

Jacob T. 1975. Morphology and paleoecology of early man in Java. In R. Tuttle (ed): *Paleoanthropology, Morphology, and Paleoecology*, pp. 311-325. Mouton, The Hague.

Jacob T. 1976. Early populations in the Indonesian region. In R.L. Kirk & A.G. Thorne (eds): *The origin of the Australians*. Human Biology Series No. 6, Australian Institute for Aboriginal Studies. Humanities Press, New Jersey.

Jacob T. 1978a. The puzzle of Solo Man. *Modern Quaternary Research in Southeast Asia*, 4: 31-40.

Jacob T. 1978b New finds of lower and middle Pleistocene hominines from Indonesia and an examination of their antiquity. In F. Ikawa-Smith (ed.): *Early Paleolithic in South and East Asia*, pp. 13-22. Mouton Publ., Paris.

Jacob T. 1979. Hominine evolution in south East Asia. *Archaeology and Physical Anthropology in Oceania*, 14: 1-10.

Jacob T. 1981. Solo Man and Peking Man. In Sigmon & Cybulski (eds:) *Homo erectus: Papers in Honor of Davidson Black*, pp. 87-104. University of Toronto Press, Toronto.

Jacob T. 1984. The fossil skull cap from Sambungmacan and its implication for human evolution. *Berkala Bioanthropologi Indonesia*, 5: 19-27.

Jacob T. 2001. Biological aspects of *Homo erectus* through the time-space continuum. In T. Simanjuntak, B. Prasetyo & R. Handini (eds): *Sangiran: Man, Culture and Environment in Pleistocene Times*, pp. 19-23. Yayasan Obor Indonesia, Jakarta.

Jones F.W. 1934. Tasmania's Vanished Race. *Australian Broadcasting Commission*. Pgs. 1-32.

Kaifu Y. 2006. Advanced dental reduction in Javanese *Homo erectus*. *Anthropol. Sci.*, 114: 35-43.

Keith A. 1925. *The Antiquity of Man*. 2nd edition. Williams and Norgate, Ltd., London.

Kennedy G.E. 1991. On the autapomorphic traits of *Homo erectus*. *J. Hum. Evol.*, 20: 375-412.

Kidder J.H. & Durband A.C. 2000. The question of speciation in *Homo erectus* revisited I: the metric evidence. *Am. J. Phys. Anthropol.*, Suppl. 30: 195.

Kidder J.H. & Durband A.C. 2004. A re-evaluation of the metric diversity within *Homo erectus*. *J. Hum. Evol.*, 46: 297-313.

Kramer A. 1989. *The Evolutionary and Taxonomic Affinities of the Sangiran Mandibles of Central Java, Indonesia.* Unpublished Ph.D. Dissertation, University of Michigan.

Kramer A. 1991. Modern human origins in Australasia: Replacement or evolution? *Am. J. Phys. Anthropol.*, 86:455-473.

Kramer A. 1993. Human taxonomic diversity in the Pleistocene: Does *Homo erectus* represent multiple hominid species? *Am. J. Phys. Anthropol.*, 91:161-171.

Larick R., Ciochon R.L., Zaim Y., Sudijono, Suminto, Rizal Y., Aziz F., Reagan M. & Heizler M. 2001. Early Pleistocene 40Ar/39Ar ages for Bapang formation hominids, Central Jawa, Indonesia. *Proc. Natl. Acad. Sci. USA*, 98: 4866-4871.

Larnach S.L. 1974. The origin of the Australian Aboriginal. *Archaeology and Physical Anthropology in Oceania*, 9: 206-213.

Le Gros Clark, W.E. 1937. The status of Pithecanthropus. *Man*, 37: 60-62.

Long V.T., de Vos J. & Ciochon R.L. 1996. The fossil mammal fauna of the Lang Trang Caves, Vietnam, compared with southeast Asian fossil and recent mammal faunas: the geographical implications. *Bulletin of the Indo-Pacific Prehistory Association*, 14: 101-109.

Lordkipanidze D., Vekua A., Ferring R., Rightmire G.P., Zollikofer C.P.E., Ponce De Leon M.S., Agusti J., Kiladze G., Mouskhelishvili A., Nioradze M. & Tappen M. 2006. A fourth hominin skull from Dmanisi, Georgia. *Anat. Rec.*, 288A: 1146-1157.

Macintosh N.W.G. 1963. Origin and physical differentiation of the Australian Aborigines. *Australian Natural History*, 14: 248-252.

Macintosh N.W.G. 1965. The physical aspect of man in Australia. In R.M. Berndt & C.H. Berndt (eds): *Aboriginal Man in Australia*, pp. 29-70. Angus and Robertson, Sydney.

Macintosh N.W.G. 1967a. Fossil Man in Australia: with particular reference to the 1965 discovery at Green Gully near Keilor, Victoria. *Aust J. Sci.,* 30: 86-98.

Macintosh N.W.G. 1967b. Recent discoveries of early Australian man. *Ann. Aust. Coll. Dent. Surg.*, 1: 104-126.

Macintosh N.W.G. & Larnach S.L. 1976. Aboriginal affinities looked at in world context. In R.L. Kirk & A.G. Thorne (eds): *The Origin* *of the Australians*, pp. 114-126. Humanities Press, New Jersey.

Morrison J. 1967 The Biracial Origin of the Australian Aborigines. *Med. J. Aust.*, 2: 1055-1056.

Neves W.A., Powell J.F. & Ozolins E.G. 1999. Modern human origins as seen from the peripheries. *J. Hum. Evol.,* 37: 129-133.

O'Connell J.F. & Allen J. 2004. Dating the colonization of Sahul (Pleistocene Australia – New Guinea): a review of recent research. *J. Arch. Sci.*, 31: 835-853.

Oppenoorth W.F.F. 1932a. *Homo (Javanthropus) Soloensis*. Een Plistoceene mensch van Java. *Wetensch. Meded. Van den Dienst van den Mijnbouw Nederlandsch-Indië,* No. 20: 49-63.

Oppenoorth W.F.F. 1932b. De vondst van paleolithische menschelijke schedels op Java. *De Mijningenieur, Bandoeng,* No. 5: 106-115.

Oppenoorth W.F.F. 1932c. Ein Neuer diluvialer Urmensch von Java. *Nat. u. Mus., Frankfort*, 62: 269-279.

Oppenoorth W.F.F. 1937. The Place of Homo Soloensis Among Fossil Men. In G.G. MacCurdy (ed): *Early Man*, pp. 349-360. JB Lippincott Co., New York.

Pardoe C. 1991. Review article: Competing paradigms and ancient human remains: the state of the discipline. *Archaeology in Oceania*, 26: 79-85.

Pardoe C. 2003. The Menindee Lakes: A Regional Archaeology. *Australian Archaeology*, 57: 42-53.

Pietrusewsky M. 1979. Craniometric variation in Pleistocene Australian and more recent Australian and New Guinea populations studied by multivariate procedures. *Occasional Papers in Human Biology*, 2: 83-123.

Rayner D.R.T., Durband A.C. & Westaway M. 2006. A reassessment of the "gracile" vs "robust" dichotomy in the Pleistocene of Australia. *Am. J. Phys. Anthropol.,* Suppl. 42: 186.

Relethford J.H. 2001. Ancient DNA and the origin of modern humans. *Proc. Natl. Acad. Sci. USA*, 98: 390-391.

Rightmire G.P. 1981. Patterns in the evolution of *Homo erectus*. *Paleobiology*, 7: 241-246.

Rightmire G.P. 1984. Comparisons of *Homo erectus* from Africa and Southeast Asia. *Courier Forschungsinstitut Senckenberg*, 69: 83-98.

Rightmire G.P. 1990. *The Evolution of Homo erectus: Comparative anatomical studies of an extinct human species*. Cambridge University Press, Cambridge.

Rightmire G.P. 1992. *Homo erectus*: Ancestor or evolutionary side branch? *Evol. Anthropol.*, 1: 43-49.

Rightmire G.P. 1994. The relationship of *Homo erectus* to later middle Pleistocene hominids. *Courier Forschungsinstitut Senckenberg*, 171: 319-326.

Rightmire G.P. 2004. Brain size and encephalization in early to mid-Pleistocene *Homo*. *Am. J. Phys. Anthropol.*, 124: 109-123.

Rightmire G.P., Lordkipanidze D. & Vekua A. 2006. Anatomical descriptions, comparative studies and evolutionary significance of the hominin skulls from Dmanisi, Republic of Georgia. *J. Hum. Evol.*, 50: 115-141.

Santa Luca A.P. 1977. *A Comparative Study of the Ngandong Fossil Hominids*. Unpublished Ph.D. Dissertation, Harvard University.

Santa Luca A.P. 1980. The Ngandong fossil hominids: A comparative study of a Far Eastern *Homo erectus* group. *Yale University Publications in Anthropology*, 78. 175 Pgs.

Sartono S. 1964. On a new find of another *Pithecanthropus* skull: an announcement. *Bulletin of the Geological Society of Indonesia*, 1: 2-5.

Sartono S. 1967. An additional skull cap of a *Pithecanthropus*. *Journal of the Anthropological Society of Nippon,* 75: 754.

Sartono S. 1968. Early man in Java: *Pithecanthropus* VII, a male specimen of *Pithecanthropus erectus* (I). *Proc. Koninklijke Nederlandse Akademie Wetenschappen, Series B*, 71: 5.

Sartono S. 1971. Observations on a new skull of *Pithecanthropus erectus* (*Pithecanthropus* VIII) from Sangiran, Central Java. *Proc. Koninklijke Nederlandse Akademie Wetenschappen, Series B*, 74: 2.

Sartono S. 1972. Discovery of another hominid skull at Sangiran, Central Java. *Curr. Anthropol.*, 13: 124-126.

Sartono S. 1975. Implications arising from

Pithecanthropus VIII. In R. Tuttle (ed): *Paleoanthropology, Morphology, and Paleoecology*, pp. 327-360. Mouton, The Hague.

Sartono S. 1990. A new *Homo erectus* skull from Ngawi, east Java. *Bulletin of the Indo-Pacific Prehistory Association*, 11: 14-22.

Shipman P. 2001. *The Man Who Found The Missing Link: Eugene Dubois and his lifelong quest to prove Darwin right*. Simon & Schuster, New York.

Sim R. & Thorne A.G. 1990. Pleistocene human remains from King Island, Southeastern Australia. *Australian Archaeology*, 31: 44-51.

Sim R. & Thorne A.G. 1995. Reply to Brown: Australian Archaeology, Number 38, 1994. *Australian Archaeology*, 41: 29.

Simpson J.J. & Grün R. 1998. Non-destructive gamma spectrometric U-series dating. *Quaternary Geochronology*, 17: 1009-1022.

Smith C.I., Chamberlain A.T., Riley M.S., Stringer C. & Collins M.J. 2003. The thermal history of human fossils and the likelihood of successful DNA amplification. *J. Hum. Evol.*, 45: 203-217.

Stone T. & Cupper M.L. 2003. Last glacial maximum ages for robust humans at Kow Swamp, southern Australia. *J. Hum. Evol.*, 45: 99-111.

Storm P. 2000. The evolutionary history of humans in Australasia from an environmental perspective. *Anthropol. Sci.*, 108: 225-244.

Storm P. 2001a. Life and death of *Homo erectus* in Australasia: an environmental approach to the fate of a paleospecies. In F. Sémah, C. Falguères, D. Grimaud-Hervé & A-M. Sémah (eds): *Origine Des Peuplements Et Chronologie Des Cultures Paléolithiques Dans Le Sud-Est Asiatique*, pp. 279-298. Semenanjung, Paris.

Storm P. 2001b. The evolution of humans in Australasia from an environmental perspective. *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 171: 363-383.

Stringer C.B. 1984. The definition of *Homo erectus* and the existence of the species in Africa and Europe. *Courier Forschungsinstitut Senckenberg*, 69: 131-143.

Stringer CB (1989) The origin of early modern humans: A comparison of the European and non-European evidence. In Mellars P. & Stringer, CB, (eds): *The Human Revolution.* Edinburgh Univ. Press, Edinburgh.

Stringer CB (1992) Replacement, continuity, and the origin of *Homo sapiens*. In (Bräuer, G and Smith, FH, eds.) *Continuity or Replacement: Controversies in Homo sapiens Evolution*. Rotterdam: AA Balkema. Pgs. 9-24.

Stringer C.B. 1994. Out of Africa - a personal history. In (Nitecki and Nitecki, eds.) *Origins of Anatomically Modern Humans*. New York: Plenum Press. Pgs. 150-170.

Stringer C.B. 1998. A metrical study of the WLH-50 calvaria. *J. Hum. Evol.* 34: 327-332.

Stringer C.B. & Andrews P. 1988. Genetic and fossil evidence for the origin of modern humans. *Science* 239: 1263-1268.

Swisher III C.C., Rink W.J., Antón S.C., Schwarcz H.P., Curtis G.H., Suprijo A. & Widiasmoro. 1996. Latest *Homo erectus* of Java: Potential contemporaneity with *Homo sapiens* in Southeast Asia. *Science*, 274: 1870-1874.

Theunissen B. 1989. *Eugene Dubois and the Ape-Man from Java: The history of the first "missing link" and its discoverer*. Kluwer Academic Publishers, Dordrecht.

Thorne A.G. 1971. Mungo and Kow Swamp: morphological variation in Pleistocene Australians. *Mankind*, 8: 85-89.

Thorne A.G. 1975. *Kow Swamp and Lake Mungo: Towards an osteology of early man in Australia*. Unpublished Ph.D. Dissertation, University of Sydney.

Thorne A.G. 1976. Morphological contrasts in Pleistocene Australians. In R.L. Kirk & A.G. Thorne (eds): *The Origin of the Australians*, pp. 95-112. Humanities Press, New Jersey.

Thorne A.G. 1977. Separation or reconciliation? Biological clues to the development of Australian society. In: J. Allen, J. Golson & R. Jones (eds): *Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melanesia, and Australia*, pp. 187-204. Academic Press, New York.

Thorne A.G. 1980 The longest link: human evolution in Southeast Asia and the settlement of Australia. In J.J. Fox, R. Garnaut, P. McCawley & J. Mackie (eds): *Indonesia: Australian*

Perspectives, pp. 35-43. Australian National University, Canberra.

Thorne A.G. 1981. The center and the edge: The significance of Australian hominids to African palaeoanthropology. *Proceedings of the Pan-African Congress of Prehistory (Nairobi),* pp. 180-181. National Museums of Kenya, Nairobi.

Thorne A.G. 1984. Australia's Human Origins – How Many Sources? *Am. J. Phys. Anthropol.*, Suppl. 63: 227.

Thorne A.G. 1989. The emergence of the Pacific peoples. *Proceedings of the 1988 Conference of the Australian Society for Human Biology,* pp. 103-111.University of Western Australia.

Thorne A.G. 2002. Not out of Africa. *Discover*, 23(8): 51-57.

Thorne A.G., Grün R., Mortimer G., Spooner N.A., Simpson J.J., McCulloch M., Taylor L. & Curnoe D. 1999. Australia's oldest human remains: age of the Lake Mungo 3 skeleton. *J. Hum. Evol.*, 36: 591-612.

Thorne A.G. & Sim R. 1994. The gracile male skeleton from late Pleistocene King Island, Australia. *Australian Archaeology*, 38: 8-10.

Thorne A.G. & Wilson S.R. 1977. Pleistocene and recent Australians: A multivariate comparison. *J. Hum. Evol.*, 6: 393-402.

Thorne A.G. & Wolpoff M.H. 1981. Regional continuity in Australasian Pleistocene hominid evolution. *Am. J. Phys. Anthropol.*, 55: 337-349.

Thorne A.G. & Wolpoff M.H. 1992. The multiregional evolution of humans. *Sci. Am.*, 266: 76-83.

van den Bergh G.D., de Vos J. & Sondaar P.Y. 2001. The late Quaternary palaeogeography of mammal evolution in the Indonesian archipelago. *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 171: 385-408.

Vekua A., Lordkipanizde D., Rightmire G.P., Agusti J., Ferring R., Maisuradze G., Mouskhelishvili A., Mioradze M., Ponce de Leon M., Tappen M., Tvalchrelidze M. & Zollikofer C. 2002. A new skull of early *Homo* from Dmanisi, Georgia. *Science*, 297: 85-89.

von Koenigswald G.H.R. 1937. A review of the stratigraphy of Java and its relations to early man. In G.G. MacCurdy (ed): *Early Man*. Pgs. 23-33. JB Lippincott Co., New York.

von Koenigswald G.H.R. 1956. *Meeting Prehistoric Man.* Thames and Hudson, New York.

von Koenigswald G.H.R. & Weidenreich F. 1939. The relationship between *Pithecanthropus* and *Sinanthropus*. *Nature*, 144: 926-929.

Webb S.G. 1989. *The Willandra Lakes Hominids.* Occasional Papers in Prehistory 16. Australian National University, Canberra.

Webb S.G. 1990. Cranial thickening in an Australian hominid as a possible palaeoepidemiological indicator. *Am. J. Phys. Anthropol.*, 82: 403-412.

Webb S.G. 1995. Palaeopathology of Aboriginal Australians: Health and disease across a hunter-gatherer continent. Cambridge University Press, Cambridge.

Webb S.G. 2006. *The First Boat People*. Cambridge University Press, New York.

Weidenreich F. 1943. The skull of *Sinanthropus pekinensis*: a comparative study on a primitive hominid skull. *Palaeontologia Sinica*, New Series D, 10.

Weidenreich F. 1945a. Giant early man from Java and south China. *Anthropol. Pap. Am. Mus. Nat. Hist.*, 40: 1-134.

Weidenreich F. 1945b. The puzzle of Pithecanthropus. *Science and Scientists in the Netherlands Indies*, 1: 380-390.

Weidenreich F. 1946. *Apes, Giants, and Man*. University of Chicago Press, Chicago.

Weidenreich F. 1951. Morphology of Solo Man. *Anthropol. Pap. Am. Mus. Nat. Hist.*, 43: 205-90.

Wolpoff M.H. 1989. Multiregional evolution: the fossil alternative to Eden. In P. Mellars & C.B. Stringer (eds): *The Human Revolution*, pp. 62-108. Edinburgh University Press, Edinburgh.

Wolpoff M.H. 1992. Theories of modern human origins. In G. Bräuer & F.H. Smith (eds): *Continuity or Replacement: Controversies in Homo sapiens evolution*, pp. 25-64. AA Balkema Press, Rotterdam.

Wolpoff M.H. 1999. *Paleoanthropology, 2nd edition*. McGraw Hill, Boston.

Wolpoff M.H., Hawks J.D., Frayer D.W. & Hunley K. 2001. Modern Human Ancestry at the Peripheries: A Test of the Replacement Theory. *Science*, 291: 293-297.

Wolpoff M.H., Thorne A.G., Jelinek A. & Zhang Yinyun 1994. The case for sinking *Homo erectus*: 100 years of Pithecanthropus is enough! *Courier Forschungsinstitut Senckenberg*, 171: 341-361.

Wolpoff M.H., Zhi W.X. & Thorne A.G. 1984. Modern *Homo sapiens* origins: a general theory of hominid evolution involving the fossil evidence from East Asia. In F.H. Smith & F. Spencer (eds): *The Origins of Modern Humans: A Survey of the Fossil Evidence*, pp. 411-484. AR Liss, New York.

Wood B.A. 1984. The origin of *Homo erectus*. *Courier Forschungsinstitut Senckenberg*, 69: 99-111.

Wood B.A. 1991. *Koobi Fora Research Project Vol. 4: Hominid Cranial Remains*. Clarendon Press, Oxford.

Wu X. 1987. *The influence in the human evolution in Australia from China*. Collected Papers of the China-Australia Symposium on Quaternary Studies, pp. 246-250. Science Press, Beijing.

Associate Editor, Emiliano Bruner