Coll. Antropol. **31** (2007) 3: 651–659
Original scientific paper

The View from Down Under: A Test of the Multiregional Hypothesis of Modern Human Origins using the Basicranial Evidence from Australasia

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ABSTRACT

Proponents of the Multiregional Hypothesis of modern human origins have consistently stated that Australasia provides one of the most compelling examples of regional continuity in the human fossil record. According to these workers, features found in the earliest Homo erectus fossils from Sangiran, Central Java, can be traced through more advanced hominids from Ngandong and are found in fossil and recent Australian Aborigines. In order to test the hypothesis that a close evolutionary relationship exists amongst the fossils from Australasia, this study will examine the cranial base. This region of the skull is considered to be evolutionarily conservative and has relatively good representation and preservation throughout much of the Australasian record. The results of this project highlight a number of features on the cranial base in the Ngandong sample that appear to be unique not only within the region, but in the human fossil sample as a whole. Several of these features, such as the morphology of the foramen ovale, the location of the squamotympanic fissure in the roof of the temporomandibular fossa, and the extreme expression of the postcondyloid tuberosities have been pointed out by workers such as Weidenreich and Jacob in their surveys of this material. The presence of these characters in the Ngandong population, and their apparent lack of expression outside of this group, provides strong evidence of discontinuity in the Australasian fossil record.

***Keywords**: Sangiran, Java, Ngandong, Homo erectus, Australia, modern human origins*

Introduction

The origin of modern humans remains one of the most hotly contested topics in paleoanthropology. This discussion is primarily focused on the genetic contribution made to various local modern populations by the archaic human groups that preceded them. Proponents of a Multiregional evolution model (MRE) would argue that these modern populations retain a suite of characteristics that would serve as a link to these earlier human groups[1–7]. On the other hand, advocates of the various replacement models would emphasize a break between modern and archaic morphologies in different regions throughout the world, and point out discontinuities between the fossil samples[8–11] (though more recently some replacement advocates have accepted minor admixture between modern and archaic populations[12]).

Proponents of MRE have consistently stated that the material from Australasia provides one of the most compelling examples of regional continuity in the human fossil record[5]. According to these workers, features found in the earliest *Homo erectus* fossils from Sangiran, Central Java, can be traced through more advanced hominids from Ngandong and found in both fossil and recent Australian Aborigines[2–7]. These similarities were first noticed by Weidenreich[13–14], and have been applied to more recent fossil finds by Thorne and Wolpoff[2], among others. Features such as the degree of facial prognathism and malar eversion, presence of a malar tuberosity, the frontal trigone, rounding of the inferolateral border of the orbit, and others have been purported to show continuity in Australasia[2,5,7].

Received for publication October 24, 2005

Recent research has begun to question this alleged continuity, however, and suggests that these apparent similarities may have been influenced by external factors. Cultural practices such as artificial deformation of the skull have influenced the cranial morphology at sites like Kow Swamp and Coobool Creek[15–18]. This phenomenon would create the appearance of a low frontal bone, and thus a similarity with Javan *Homo erectus*, where none may have existed before the modification took place. Likewise, new reconstructions of certain key fossils, such as Sangiran 17, are forcing a re-evaluation of this proposed continuity sequence[19–21]. Baba and colleagues[21] have noted that many of the features cited as showing continuity between Sangiran 17 and the Kow Swamp sample disappeared in the new, more orthognathic reconstruction of that fossil that was recently completed. As a result of this work, the controversy surrounding the origins of modern humans in Australasia continues to plague paleoanthropologists.

Much of the previous work on this question has been focused on the cranial vault and face. While these areas are often emphasized due to their relative abundance in the fossil record, it is also important to examine other areas of the skull in an effort to maximize the data available for study. Therefore, this project will examine the cranial base, an area of the skull that is underexploited in the literature and also has relatively good preservation throughout much of the Javan and Australian fossil record. Specifically, the cranial bases present in the fossil samples from Sangiran, Ngandong, and Sambungmacan, as well as various fossil and modern samples from Australia and elsewhere will be examined in an effort to determine if any degree of similarity exists between these samples. This analysis will test the null hypothesis that a number of non-metric features show an overall similarity between these groups, and will be rejected if it can be shown that significant dissimilarity is present.

Materials

The cranial sample included in this study is shown in Table 1. The original fossil material from Ngandong as well as Sambungmacan 1, Sangiran 2, 4, 12, 14 and 17 were examined by the author. Observations noted for Sambungmacan 4 were taken from the literature[22] and a large basal photograph provided by Dr. Baba. The Pleistocene Australian sample includes four crania that have been prominantly mentioned in the modern human origins debate. It was necessary to study high-quality casts of these specimens, since the original fossils have been repatriated. The Pleistocene Australians were studied at the American Museum of Natural History. The modern human sample was obtained from both the Field Museum of Natural History and the American Museum of Natural History.

In addition to the aforementioned specimens, a large sample of fossils was studied in an effort to examine the appearance of these non-metric traits outside Australasia. While this list is certainly not exhaustive, it does comprise a diverse group of fossils from different regions and sites that will allow a reasonable test of the assumption that the non-metric features of interest will be isolated to the Australasian sample. These specimens were studied as casts at either the University of Tennessee or the American Museum of Natural History and are noted with asterisks in Table 1.

TABLE 1
CRANIAL SAMPLE EXAMINED FOR THIS PROJECT

Ngandong 1	Sangiran 2
Ngandong 6	Sangiran 4
Ngandong 7	Sangiran 12
Ngandong 10	Sangiran 14
Ngandong 11	Sangiran 17
Ngandong 12	Kow Swamp 1
Sambungmacan 1	Kow Swamp 5
Sambungmacan 3	Talgai
Ngawi	Keilor
Zhoukoudian 3*	Upper Cave 101*
Zhoukoudian 10*	Upper Cave 102*
Zhoukoudian 11*	Upper Cave 103*
Zhoukoudian 12*	Petralona*
Dali*	La Ferrassie 1*
Kabwe*	La Chapelle*
ER 3733*	Cro-Magnon 1*
ER 3883*	Predmost sample*
OH 9*	Skhul 5*
OH 12*	Steinheim*
WT 15000*	Swanscombe*
Atapuerca cranium 5*	
43 Australian	
42 S. African	
127 W. African	
25 Austrian	
25 Czech	
25 Greek	
20 Native American (Utah)	

Methods

A series of non-metric features relevant to this study was created through a survey of the literature (Table 2). These features are the postcondyloid tuberosities, the location of the foramen ovale in a pit with an additional accessory foramen, the location of the squamotympanic fissure, the opistionic recess of the foramen magnum, the orientation of the occipital condyles, and the relative size of the occipital condyles to the foramen magnum. These characters were selected because previous authors have suggested that they may be unique to the Ngandong fossils[14,22–25] and are described by Weidenreich[14] and Durband[27]. These traits are found in both males and females in the Ngandong sample (as sexed by both Weidenreich[14]

TABLE 2
CHARACTER STATES FOR THE NON-METRIC FEATURES STUDIED IN THIS PROJECT

Score	Postcondyloid tuberosities (PCT)
0	absent
1	slight rugosity
2	rugosity with discrete tubercle development
3	tubercles >10 mm in height
Score	Foramen ovale in pit with accessory foramen
0	Pit & accessory foramen absent
1	Pit & accessory foramen present
Score	Location of squamotympanic fissure
0	Squamotympanic fissure in apex of fossa
1	Squamotympanic fissure posterior to apex
Score	Opisthionic recess
0	Rear of foramen magnum rounded
1	Rear of foramen magnum slighly constricted
2	Rear of foramen magnum forms recess
Score	Orientation of occipital condyles
0	Occipital condyles parallel to midline
1	Occipital condyles taper toward midline

and Santa Luca[26]) so their presence is unlikely to be affected by sexual dimorphism. The scoring methods used for the first five traits are defined in Table 2, while the sixth, relative size of the occipital condyles to the foramen magnum, will be explained below. These observations will allow a rigorous test of the null hypothesis proposed for this study. The apparently unique features in the Ngandong sample will be examined to see if they are indeed limited to that group. Likewise, the fossil and modern crania will be examined in an effort to determine if the cranial bases present in Australasia share any of these unique features that could indicate genetic continuity with the population represented by the Ngandong sample.

Results

Postcondyloid tuberosities

The postcondyloid tuberosities (PCT) were described by Weidenreich[14] as long, rough ridges that have their origins immediately behind the occipital condyles as a high bulge that flattens out and tapers towards the posterior end of the foramen magnum. While they are most well developed in Ngandong 12, these features appear on each of the Ngandong skulls that retain the posterior rim of the foramen magnum, and also appear on Sambungmacan 1, 3, 4 and Ngawi. These tuberosities do not appear in any of the Sangiran hominids found to date, however, and have been shown to be exceedingly rare in other Pleistocene human fossils[24,27]. Therefore, they may provide the first example of a potential Ngandong autapomorphy that could serve as a link between those fossils and later Australians.

Each of the fossil Australians that were included in this study could be scored for this trait, and none show any development of the PCT beyond some slight rugosity around the posterior rim of the foramen magnum. Even Kow Swamp 5, a robust specimen often mentioned by continuity advocates, does not show development of this feature. Furthermore, this rugosity often extends to and includes opisthion, which is always quite smooth in the Ngandong fossils, so this particular morphology would appear to be absent in the fossil Australians.

TABLE 3
FREQUENCY OF POSTCONDYLOID TUBEROSITIES IN NGANDONG AND THE MODERN SAMPLES

Sample	0–1	2	3
Ngandong (N=8)	0.00	0.00	100.00
Australia	44.18	48.84	6.98
Austria	75.00	25.00	0.00
Czech	68.00	28.00	4.00
Greece	88.00	8.00	4.00
Utah	90.00	5.00	5.00
S. Africa	89.29	10.71	0.00
W. Africa	89.29	10.71	0.00

The frequencies for this trait in the modern human sample can be seen in Table 3. Unlike the early Australians, however, recent Australians do show some PCT development in approximately half the crania studied, which is more frequently than observed in any other recent sample. However, PCT projection in excess of 10 mm (as observed on the Ngandong crania) occurs only rarely in recent Australians and was recorded at similar frequencies in two European samples and the sample from Utah. Further, the tuberosities present on the modern crania tend to be smaller and narrower both relatively and absolutely than those on the Ngandong fossils. In addition, the modern crania also often exhibit rugosity that extends completely around the rear of the foramen magnum in addition to the tubercle development. Rugosity at opisthion is not found in the Ngandong specimens. Thus, it is not clear whether the particular manifestations of these tuberosities are homologous in both the Ngandong fossils and the modern humans. In short, while the PCT may not be limited to the Ngandong hominids and can be found in modern populations today, the particular morphology of these tuberosities appears to differ between these two samples.

Foramen ovale

The morphology of the foramen ovale is also worthy of note in the Ngandong fossils[14,22–23,28] and Sambungmacan 4[22]. While only three crania retain this foramen, in

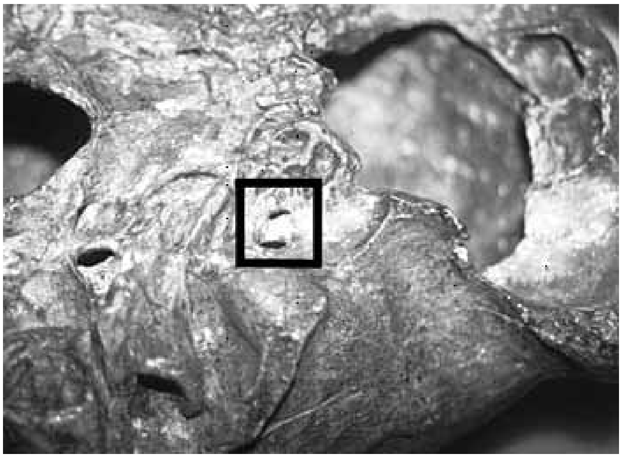

Fig. 1. The left foramen ovale of Ngandong 12, with both the accessory foramen (top), septum, and f. ovale (bottom) visible in the square highlighting the area.

each specimen it is very well preserved and shows a very interesting morphology. The foramen is located at the base of a deep pit, which houses both the main foramen as well as an accessory foramen that is separated from the primary channel by a relatively wide septum (Figure 1). This morphology can be seen on all six of the surviving foramina in these crania, so it is likely to be typical for these hominids. Jacob[28] has noted that this character is not a foramen of Vesalius, Hyrtl, or Civinini, or any of the other common variations seen in modern human populations today. Weidenreich[14] feels that the accessory foramen might transmit the motor root of the mandibular nerve of the trigeminal nerve. Jacob[28] adds that the accessory meningeal artery might also pass through the opening.

TABLE 4
FREQUENCIES OF THE ACCESSORY FORAMEN OVALE AND OVALE PIT IN NGANDONG AND THE MODERN SAMPLES

Sample	Absent	Present
Ngandong (N=3)	0	100
Australia	100	0
Austria	100	0
Czech	100	0
Greece	100	0
Utah	100	0
S. Africa	100	0
W. Africa	100	0

The observations for this feature are shown in Table 4. This morphology has not been seen in any other fossil or modern human that was examined, nor am I aware of any other researchers who have found it outside of the three skulls already mentioned. Thorne[29] specifically mentions that this foramen is *not* doubled in any of the hominids from Lake Mungo and Kow Swamp. While the foramen of Vesalius was commonly seen during this study, nothing approaching the condition seen in Ngandong 7, 12 and Sambungmacan 4 was noted.

Squamotympanic fissure in roof of TMJ

A third morphology deemed to be potentially unique to the Ngandong hominids is the location of the squamotympanic fissure wholly in the roof of the temporomandibular joint[14,23,25,30]. Weidenreich[14] was the first to notice this character, and Larnach and Macintosh[23] later studied it as well. In each of the specimens from Ngandong, as well as Ngawi and Sambungmacan 1 and 3, the roof of the TMJ continues to slope superiorly until the fissure is reached at the apex[22,25]. This condition differs from that in all other hominid specimens examined, in which the roof of the fossa reaches its apex and then slopes inferiorly to a postglenoid tubercle, which is anterior to the aforementioned fissure (Figure 2). While some authors have claimed that the location of this fissure appears to be somewhat different in Ngandong 7, this appears to be due to slight plastic deformation in the area in question. In this specimen, as well as Ngandong 10, the zygomatic process of the temporal bone is depressed slightly inferiorly, causing the squamous portion of the mandibular fossa to bend at the lateral edge. This inferior projection of the lateral edge of the TMJ is unlike the morphologies displayed in the rest of the Ngandong series, and tests to quantify the degree of this deformation are currently underway.

TABLE 5
FREQUENCIES FOR THE LOCATION OF THE SQUAMOTYMPANIC FISSURE IN NGANDONG AND THE MODERN SAMPLES

Sample	Posterior	In apex
Ngandong (N=9)	0	100
Australia	100	0
Austria	100	0
Czech	100	0
Greece	100	0
Utah	100	0
S. Africa	100	0
W. Africa	100	0

As with the configuration seen in the foramen ovale, the location of the squamotympanic fissure appears to be unique to the hominids from Ngandong, Sambungmacan, and Ngawi. None of the hominids from Sangiran show a similar morphology, nor do any fossil Australian specimens. Even Wolpoff and Thorne[2] point out that the position of the squamotympanic fissure (which they call the Glaserian fissure) in the Ngandong skulls differs from the condition seen in the rest of the Indonesian fossil sample. Likewise, Thorne[29] notes that the hominids from Kow Swamp and Lake Mungo all lack this feature.

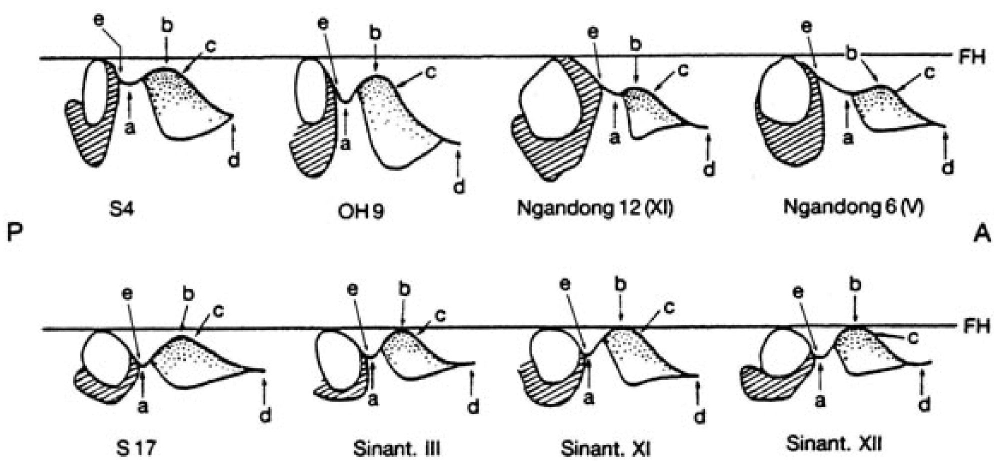

Fig. 2. Parasagittal profiles of the mandibular fossae of various fossil specimens. Taken from Durband (2002) modified from Picq (1983). a – postglenoid tubercle, b – deepest portion of the articular area, c – anterior limit of concave roof of fossa, d – articular tubercle, e – squamotympanic fissure.

Therefore, it is not surprising that no modern specimens examined are similar to Ngandong in this area, as can be seen in Table 5.

Opisthionic recess

The opisthionic recess refers to a narrowing of the foramen magnum in its posterior portion near opisthion. In the Ngandong skulls, particularly specimens 1 and 7, this narrowing is quite pronounced[14] and gives the foramen a distinct teardrop shape. This feature has also been noted in Sambungmacan 3[30] and Sambungmacan 4[22] as well as Ngawi, and is absent in the other fossil hominids examined in this project.

This feature was not noted on Sangiran 4 or 17, nor does it appear on any of the fossil Australian crania. Likewise, the modern crania studied only rarely show a narrowing in the posterior foramen magnum, which is almost always uniformly oval in shape. In addition, regions outside of Australia provide higher percentages of slight narrowing of the posterior foramen than the Australian populations sampled, as shown in Table 6. A single Austrian skull provided the only example of an opisthionic recess similar to that seen in the Ngandong sample. So once again, a feature that is quite prevalent in the Ngandong group of fossils is almost completely absent in any other human populations.

Orientation of occipital condyles

The orientation of the occipital condyles is also of particular interest in the Ngandong fossils. While only one example is preserved in this sample, the left condyle of Ngandong 7, the broken bases present on Ngandong 12 allowed Weidenreich[14] to reconstruct their size and position. The condyles are oriented roughly parallel to the midline, a condition that is very unusual for hominids. Two of the Sangiran fossils, crania 4 and 17, retain occipital condyles and in both specimens they taper toward the midline at their anterior end. Three of the Pleistocene Australians retain condyles, and each specimen likewise has condyles that taper toward the midline anteriorly. All of the modern Australians sampled have condyles that taper toward the midline at their anterior end, as shown in Table 7. Overall a very small percentage of the modern humans sampled have roughly parallel condyles, and this feature has proven to be extremely rare.

TABLE 6
FREQUENCIES FOR THE OPISTHIONIC RECESS IN NGANDONG AND THE MODERN SAMPLES

Sample	Absent	Slight	Present
Ngandong (N=7)	0.00	0.00	100.00
Australia	92.90	7.10	0.00
Austria	80.00	16.00	4.00
Czech	80.00	20.00	0.00
Greece	92.00	8.00	0.00
Utah	80.00	20.00	0.00
S. Africa	85.20	14.80	0.00
W. Africa	82.14	17.86	0.00

TABLE 7
ORIENTATION OF THE OCCIPITAL CONDYLES IN NGANDONG AND THE MODERN SAMPLES

Sample	Parallel	Angled
Ngandong (N=2)	100.00	0.00
Australia	0.00	100.00
Austria	8.60	91.40
Czech	8.00	92.00
djustrightGreece	0.00	100.00
Utah	10.00	90.00
S. Africa	0.00	100.00
W. Africa	3.57	96.43

TABLE 8
RATIOS OF OCCIPITAL CONDYLE AREA TO FORAMEN MAGNUM AREA IN NGANDONG AND THE MODERN SAMPLES

Sample	Average	Range	Sample size	N< 21.00
Ngandong 7	17.96			
Ngandong 12	20.75			
Sangiran 4	39.40			
Sangiran 17	31.19			
Australia	34.44	23.59–51.06	43	0
S. Africa	29.84	17.44–41.36	42	2
Czech	29.81	22.46–38.37	21	0
Austria	30.17	19.34–38.54	15	1
Greece	31.10	22.23–35.94	17	0
Utah	39.92	31.01–54.18	17	0
W. Africa	40.68	22.22–62.70	127	0

Relative size of occipital condyles to the foramen magnum

Weidenreich[14] also noted the very small size of the occipital condyles in the Ngandong population. While dimensions for these structures are available from only two specimens, as noted earlier, both crania show uniformly small condyles. When related to the size of the foramen magnum using the formula (OC L x OC W)/(FM L/2 x FM W/2 x 3.14159) provided by Wood[31], their small size becomes particularly apparent. Ngandong 7 has condyles that are 17.96% the size of the foramen magnum, while Ngandong 12 scores 20.75%. These measurements are in stark contrast to the scores from Sangiran 4 and 17, which are 39.4 and 31.2%, respectively. Likewise, the modern humans examined have considerably larger occipital condyles on average, shown in Table 8. The Australians sampled, for example, have condyles that are 34.44% the size of their foramina, with a range of 23.59 to 51.06. The other modern groups sampled have similar scores. Only three of the 282 individuals sampled have scores that fall below 21%, providing a clear contrast with the measurements obtained from the Ngandong fossils.

Tests of independence in the six cranial features studied

A polychoric correlation test was run on the data obtained in this study in an effort to determine the level of developmental interdependence in these six features in the modern human sample. The results of this statistical test, shown in Table 9, provide correlation values that can be examined for statistical significance, and also allow the calculation of the relative effect that one feature has on the manifestation of any other. Two features used in this project, location of the squamotympanic fissure and the morphology of the foramen ovale, did not vary in the modern human sample and were left out of the polychoric correlation test.

TABLE 9
POLYCHORIC CORRELATION TESTS FOR THE BASICRANIAL FEATURES STUDIED

Statistics for Condyle orientation by Opisthionic recess		
Statistic	Value	ASE
Spearman Correlation	0.0027	0.0700
Polychoric Correlation	0.0158	0.2589
Statistics for Condyle orientation by PCT		
Statistic	Value	ASE
Spearman Correlation	0.0924	0.0715
Polychoric Correlation	0.2479	0.1796
Statistics for Condyle orientation by Relative condyle size		
Statistic	Value	ASE
Spearman Correlation	0.1034	0.0645
Polychoric Correlation	0.2868	0.1971
Statistics for Opisthionic recess by PCT		
Statistic	Value	ASE
Spearman Correlation	0.0362	0.0758
Polychoric Correlation	0.0473	0.1177
Statistics for Opisthionic recess by Relative condyle size		
Statistic	Value	ASE
Spearman Correlation	–0.0380	0.0790
Polychoric Correlation	–0.0425	0.1300
Statistics for PCT by Relative condyle size		
Statistic	Value	ASE
Spearman Correlation	0.1789	0.0762
Polychoric Correlation	0.2081	0.0871

Results for the tests examining the remaining features confirm the very low, often statistically insignificant levels of interdependence between the features studied. The majority of the Spearman correlation scores do not exceed the 0.05 p-value for statistical significance, especially when the asymptotic error values (ASE) are considered. These error values reflect the disproportionate numbers of individuals in the various cells created during the computation of the chi-square matrix.

In addition, the polychoric correlation value allows a measurement of the relative effect that each feature has on the other. The square of the polychoric correlation score provides a percentage score reflecting how change in one feature is influencing the other trait of interest. For example, the highest polychoric correlation score obtained during these examinations is 0.2868 for the combination of condyle orientation and relative condyle size. The square of this number, or 8.22%, is the influence that relative condyle size has on the manifestation of condyle orientation in this sample of modern humans. These scores indicate that there is a very low level of correlation between the basicranial features studied in this analysis, and is consistent with an interpretation of independent development of these features.

Discussion

The cranial base is considered to be one of the more evolutionarily conservative portions of the cranium, left relatively free to develop without influence from surrounding structures[32–34]. As such, it should provide an excellent opportunity to test the assumptions of MRE, namely that modern human groups in a particular region will share a suite of features with the archaic humans that preceded them. The objectives of this study were to examine the cranial bases present in the fossil sample from Australasia in order to test the null hypothesis that a number of non-metric features will show an overall similarity between Javan *Homo erectus* and fossil and modern Australians, a hypothesis which would be rejected if the results indicated that significant dissimilarity exists between these groups.

Clearly, the results of this study indicate that a rejection of the null hypothesis is required in this case. None of the features examined support a link between the hominids from Sangiran, Ngandong and Australia, and five of the six characters appear to be autapomorphic for the hominids from Ngandong, Sambungmacan, and Ngawi. The high number of unique features in the cranial bases of these hominids suggests that they had undergone considerable change from earlier forms sampled at Sangiran and Trinil, and suggests two possible evolutionary fates for this group. The subsequent disappearance of these features in later humans could imply extinction of the Ngandong hominids and replacement by modern humans, a conclusion that is highly compatible with the paleoecological evidence compiled by Storm[35–37]. Likewise, one could also argue that the absence of these more esoteric features in modern human groups is simply the result of the Ngandong gene pool being swamped by that of a larger immigrant population. However, while the diversification and extinction (or genetic swamping) of the Ngandong hominids might not negate the possibility of regional continuity between the earlier hominids from Sangiran and later Australians, there are no other fossil specimens that could serve as an intermediary between those populations either temporally or morphologically.

The notion that the hominids from Ngandong had evolved beyond the level of other specimens widely regarded as *Homo erectus* is not new. The Ngandong fossils have been very difficult to classify within the current taxonomic framework, primarily due to their large cranial capacities and apparently progressive features. As Santa Luca[38] noted after his extensive study of the Ngandong cranial vault, these hominids appear »at the advanced end of the within group *H. erectus* trends.« Kidder[39] reported similar results, finding that the Ngandong fossils »[demonstrate] metric patterns more advanced than *Homo erectus* in the shape of the vault.« Grimaud-Hervé[40] reached the same conclusion after an analysis of the parietal bones of Indonesian erectines. Most recently, Widianto and Zeitoun[41] found that the Ngandong crania, along with Sambungmacan 1 and Ngawi 1, form a »unique, homogenous series« to the exclusion of other Asian *H. erectus*. These authors all demonstrate that the cranial vaults in the Ngandong sample have become derived relative to the hominids from Sangiran and elsewhere, yet the results shown here as well as other studies[22,42,43] suggest that the Ngandong hominids are also not evolving in the direction of modern humans. Thus, these data would not provide support for an interpretation of hybridization between the Ngandong hominids and invading modern human groups, and weakens the argument for the genetic swamping of these hominids.

The taxonomic status of the Ngandong hominids is also worth considering in light of these new findings. Most authors consider the Ngandong fossils to represent late-surviving *H. erectus*[26,38,42–48], while others prefer to place them in the pseudo-taxon of archaic *H. sapiens*[49,50]. The latter assignment is generally defended by claims that the Ngandong fossils exhibit traits that are derived in the direction of modern humans, but this assertion has been called into question by various authors[9,42,43,45] as well as the present study. Zeitoun[41,51] has suggested the resurrection of the species *Homo soloensis* to encompass the hominids from Ngandong, Sambungmacan, and Ngawi. This solution is based on the premise that these specimens represent »a particular geographically and chronologically restricted human group defined by unique morphological and biometrical data«[41]. The resurrection of *Homo soloensis* is supported by the present study, which has highlighted a number of autapomorphic features on the cranial base that appear to be both distinctive for and diagnostic of this group. This combination of unique traits, in conjunction with the previously cited studies discussing the progressive metric features of the Ngandong, Sambungmacan, and Ngawi cranial vaults[26,39–41], provides a strong case for separating these crania from *Homo erectus*.

Further study will be devoted to increasing the sample of Pleistocene and early Holocene Australian fossils, as well as increasing the survey of other human fossils in an effort to rigorously test the notion that these features are indeed isolated to the fossils from Ngandong, Sambungmacan, and Ngawi. However, the results reported here, in conjunction with the author's earlier work on these features[24,25,27], strongly imply that this late surviving population of archaic Javan hominids went extinct after differentiating considerably from the earlier Sangiran hominids.

Acknowledgements

I would like to acknowledge the University of Tennessee, Northern Illinois University, Sigma Xi, and the American Museum of Natural History for financial support for this project. Fachroel Aziz, Teuku Jacob, and Friedemann Schrenk allowed access to original fossil materials in their care. Tony Djubiantono provided access to casts and other materials in his laboratory. This work benefited from discussions with Jim Kidder, Ken Mowbray, Sam Márquez, and Marc Oxenham. Andrew Kramer and Dan Weinand critiqued early drafts of this paper, and

Lisa Nevell offered some particularly helpful comments on my arguments. Mike O'Neil of the Statistical Consulting Lab at the University of Tennessee provided assistance with the polychoric correlation tests. Yousuke Kaifu and an anonymous reviewer provided comments that improved the final version of this paper.

REFERENCES

1. THORNE A, Separation or Reconciliation? Biological Clues to the Development of Australian Society. In: ALLEN J, GOLSON J, JONES R (Eds) Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melanesia, and Australia (Academic Press, New York, 1977). — 2. THORNE A, WOLPOFF MH, Am J Phys Anthropol, 55 (1981) 337. — 3. WOLPOFF MH, Multiregional evolution: the fossil alternative to Eden. In: MELLARS P, STRINGER C (Eds) The Human Revolution (Edinburgh University Press, Edinburgh, 1989). — 4. WOLPOFF MH, Theories of modern human origins. In: BRÄUER G, SMITH F (Eds) Continuity or Replacement: Controversies in *Homo sapiens* evolution (AA Balkema Press, Rotterdam, 1992). — 5. WOLPOFF MH, Paleoanthropology, 2nd edition (McGraw Hill, Boston, 1999). — 6. WOLPOFF MH, WU X, THORNE A, Modern *Homo sapiens* origins: a general theory of hominid evolution involving the fossil evidence from East Asia. In: SMITH F, SPENCER F (Eds) The Origins of Modern Humans: A Survey of the Fossil Evidence (AR Liss, New York, 1984). — 7. WOLPOFF MH, HAWKS J, FRAYER D, HUNLEY K, Science, 291 (2001) 293. — 8. STRINGER C, The origin of early modern humans: a comparison of the European and non-European evidence. In: MELLARS P, STRINGER C (Eds) The Human Revolution (Edinburgh University Press, Edinburgh, 1989). — 9. STRINGER C, Replacement, continuity, and the origin of *Homo sapiens*. In: SMITH F, SPENCER F (Eds) The Origins of Modern Humans: A Survey of the Fossil Evidence (AR Liss, New York, 1984). — 10. STRINGER C, Out of Africa – a personal history. In: NITECKI M, and NITECKI D (Eds) Origins of Anatomically Modern Humans (Plenum Press: New York, 1994). 11. STRINGER C, ANDREWS P, Science, 239 (1988) 1263. — 12. BRÄUER G, COLLARD M, STRINGER C, Anat Rec, 279A (2004) 701. — 13. WEIDENREICH F, Palaeontologia Sinica, New Series D 10 (1943). — 14. WEIDENREICH F, Anthropol Pap Am Mus Nat Hist, 43 (1951) 205. — 15. BROWN P, Archaeology in Oceania, 16 (1981) 156. — 16. BROWN P, Terra Australis 13 (1989). — 17. ANTÓN S, WEINSTEIN K, J Hum Evol, 36 (1999) 195. — 18. DURBAND AC, J Hum Evol (submitted). — 19. AZIZ F, BABA H, WATANABE N, GRDC Paleontology Series, 8 (1996) 11. — 20. BABA H, AZIZ F, NARASAKI S, Bull Natn Sci Mus Tokyo Ser D, 24 (1998) 1. — 21. BABA H, AZIZ F, NARASAKI S, Acta Anthropologica Sinica, Vol 19 Suppl (2000) 57. — 22. BABA H, AZIZ F, KAIFU Y, SUWA G, KONO R, JACOB T, Science, 299 (2003) 1384. — 23. LARNACH S, MACINTOSH N, A comparative study of Solo and Australian Aboriginal Crania. In: ELKIN, MACINTOSH, N (Eds) Grafton Elliot Smith: The man and his work (Griffin Press, Adelaide, 1974). — 24. DURBAND AC, Am J Phys Anthropol, Suppl 26 (1998) 79. — 25. DURBAND AC, Anat Rec, 266 (2002) 138. — 26. SANTA LUCA AP, Yale University Publications in Anthropology, 78 (1980). — 27. DURBAND AC, The Ngandong Fossil Hominids: A Morphometric Analysis of the Cranial Base and its Implications for the Origins of Modern Humans, [MS Thesis] (Northern Illinois University, DeKalb, 1997). — 28. JACOB T, Some problems pertaining to the racial history of the Indonesian Region (Drukkerij Neerlandia, Utrecht, 1967). — 29. THORNE A, Kow Swamp and Lake Mungo: Towards an osteology of early man in Australia, [PhD Dissertation] (University of Sydney, Sydney, 1975). — 30. DELSON E, HARVATI K, REDDY D, MARCUS L, MOWBRAY K, SAWYER G, JACOB T, MÁRQUEZ S, Anat Rec, 262 (2001) 380. — 31. WOOD BA, Koobi Fora Research Project Vol. 4: Hominid Cranial Remains (Clarendon Press, Oxford, 1991). — 32. VAN LIMBORGH J, Acta Morph Neerl-Scand, 8 (1970) 143. — 33. BURDI A, Early development of the human basicranium: its morphogenic controls, growth patterns, and relations. In: BOSMA J (Ed.) Development of the Basicranium. DHEW Publication No. (NIH) 76–989 (NIH, Bethesda, 1976). — 34. [MAHEL Z, ŠKVARILOVA B, Am J Phys Anthropol, 77 (1988) 221. — 35. STORM P, Anthropol Sci, 108 (2000) 225. — 36. STORM P, Life and death of *Homo erectus* in Australasia: an environmental approach to the fate of a paleospecies. In: SÉMAH F, FALGUÈRES C, GRIMAUD-HERVÉ D, SÉMAH A (Eds) Origine Des Peuplements Et Chronologie Des Cultures Paléolithiques Dans Le Sud-Est Asiatique (Semenanjung, Paris, 2001). — 37. STORM P, Palaeogeogr Palaeoclimatol Palaeoecol, 171 (2001) 363. — 38. SANTA LUCA AP, A Comparative Study of the Ngandong Fossil Hominids, [PhD Dissertation] (Harvard University, Cambridge, 1977). — 39. KIDDER J, Defining anatomically modern *Homo sapiens* in the context of modern human origins: A size and shape approach. [PhD Dissertation] (University of Tennessee, Knoxville, 1996). — 40. GRIMAUD-HERVÉ D, Human Evolution, 1 (1986) 167. — 41. WIDIANTO H, ZEITOUN V, International Journal of Osteoarchaeology, 13 (2003) 339. — 42. RIGHTMIRE GP, The Evolution of *Homo erectus*: Comparative anatomical studies of an extinct human species. (Cambridge, Cambridge Univ. Press, 1990). — 43. RIGHTMIRE GP, Am J Phys Anthropol, 124 (2004) 109. — 44. RIGHTMIRE GP, Paleobiology, 7 (1981) 241. — 45. RIGHTMIRE GP, Courier Forsch Inst Senckenberg, 171 (1994) 319. — 46. ANTÓN S, Geological Research Development Centre Special Publication 27 (2001) 39. — 47. ANTÓN S, Am J Phys Anthropol, 118 (2002) 301. — 48. ANTÓN S, Yearb Phys Anthropol, 37 (2003) 126. — 49. BRÄUER G, Africa's place in the evolution of *Homo sapiens*. In: BRÄUER G, SMITH F (Eds) Continuity or Replacement: Controversies in *Homo sapiens* evolution (AA Balkema Press, Rotterdam, 1992). — 50. BRÄUER G, MBUA E, J Hum Evol, 22 (1992) 79. — 51. ZEITOUN V, Asian palaeoanthropology: Homo soloensis reconsidered? Paper presented at the 17th Congress of the Indo-Pacific Prehistory Association, Taipei, Taiwan, September 9-15-2002.

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TEST MULTIREGIONALNE HIPOTEZE MODERNIH LJUDSKIH PREDAKA NA OSNOVI BAZIKRANIALNIH DOKAZA IZ AUSTRALIJE

S A Ž E T A K

Pristalice multiregionalne hipoteze modernih ljudskih predaka navode kako je Australija najkonzistentniji regionalni primjer kontinuiteta ljudskih fosilnih ostataka. Prema tim znanstvenicima, karakteristike pronađene kod fosila ranih Homo erectusa iz Sangriana, Centralna Java, mogu biti uspoređivani sa naprednijim fosilima iz Ngandonga kao i sa australijskim Aboriđinima. Ova studija za cilj je imala utvrditi te hipoteze istražujući kranialnu bazu. Ovaj dio lubanje se evolutivno gledajući smatra nepromjenjivim te je stoga reprezentivan za proučavanje australskih uzoraka. Rezultat ovog projekta je nekoliko otkrivenih karakteristika kranialne baze ngandongskog primjerka koji ne samo da se podudara sa cijelom regijom već i sa ljudskim fosilima uopće. Weidenreich i Jacob istaknuli su nekoliko takvih karakteristika, kao što su morfologija ovalnog otvora, skvamotimpaničnog šava i postkondilarnog izbočenja. Prisutnost ovih karakteristika u Ngandongskoj populaciji te izostanak istih izvan ove grupe, dokazuje diskontinuiranost australskih fosilni nalaza.