

MEGANTHROPUS AND THE HOMINID TAXA OF JAVA

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ABSTRACT

This study examines the single species null hypothesis for Asian pre-modern hominids by comparing six mandibular measures from samples of Javanese and Chinese fossils attributed by the dominant hypothesis to Homo erectus. This analysis indicates that the hypothesis is found wanting. The study suggests that the Javanese sample is far too diverse to comply with the variation expected for a single hominid species.

INTRODUCTION

The unilineal view of Asian hominid evolution has prevailed in the literature for decades (Weidenreich 1945; Lovejoy 1970; Thorne and Wolpoff 1981; Pope 1983, 1984; Pope and Cronin 1984; Kramer 1989, 1994). Some scholars have tended to the earlier taxonomic fashion of multiple taxa, with several genera and many species (Marks 1953; Jacob 1967, 1973). However, the hypothesis which continues to dominate debate, and about which consensus has largely been reached in the West at least, is that all the pre-modern material belongs to a single taxon: *Homo erectus*. This species is thought to have undergone a late Pleistocene transition, either gradually (Weidenreich 1945; Thorne and Wolpoff 1981), or by extinction in the face of rapid replacement (Stringer and Andrews 1988), to our own species. Variability in morphology of the pre-modern fossils, according to this single species hypothesis, is explained by anagenesis or sexual dimorphism.

It is now recognised that the existence of a single species in a fossil sample cannot be proven. Rather, the idea of a single species is merely the null hypothesis to be falsified (Martin 1991). It is generally accepted that

the null hypothesis can be tested by comparison of the levels of variation in the fossil samples with those of various extant species (Gingerich 1974; Tattersall 1986; Martin 1991).

This paper tests the single species null hypothesis for Asian pre-modern hominids by comparing six mandibular measures from samples of Javanese and Chinese fossils attributed by the dominant hypothesis to *H. erectus*. It also looks at hominid mandibular variation and the implications this has for the number of species present in an assemblage. Calculations are on data taken from the literature (Weidenreich 1945; Marks 1953; Sartono 1961; Chamberlain and Wood 1985; Tobias 1991).

VARIATION IN MORPHOLOGY

The set of Indonesian mandibles from Sangiran, Central Java, are particularly interesting because their robusticity has stimulated some taxonomists to allocate them to species and genera of the Hominidae other than *H. erectus*. The mandibles S1b, S5, S6, S8 and S9 have been placed in taxa such as *Meganthropus palaeojavanicus*, *Pithecanthropus dubius*, *P. robustus*, and even *Australopithecus* (Weidenreich 1945; Marks 1953; Robinson 1953, 1955; von Koenigswald 1954, 1973; Jacob 1967, 1973; Matsu'ura 1982; Sartono 1982, 1985; Day 1984; Franzen 1985a, 1985b). From the advocates of the single species hypothesis, the response has been to re-assert unilinearity, dismissing robusticity as attributable to earlier phases or hyper-robust versions of basic *H. erectus* morphology (Lovejoy 1970; Pope 1983, 1984; Pope and Cronin 1984; Kramer 1989 1994).

It has been shown that when the standard variability measure, coefficient of variation (CV), is greater than 10, there is strong evidence that more than one species is represented in a fossil sample (Simpson, Roe and Lewontin 1960; Groves 1989). This is especially true for

Table 1: Variability in mandibular measures for Javanese and Chinese *H. erectus*. Thickness and height measurements (mm).

Measure	n	Range	x	s	CV
Thickness at symphysis	9	12.7-25.5	16.3	4.1	25.0
Thickness at mental foramen	10	14.7-28.0	18.0	4.0	22.4
Thickness at m_2/m_3	9	15.4-26.3	19.2	3.8	19.9
Height at symphysis	8	28.8-47.0	37.4	5.9	15.8
Height at mental foramen	11	25.2-48.0	33.2	7.9	23.6
Height at m_2/m_3	9	25.0-47.0	32.6	8.1	24.7

Table 2: Comparison of Javanese and Chinese mandibles.

Raw thickness and height measurements (mm). Sample sizes down the rows are respectively: 4,5,5,5,4,5,4,4,6,5,5,4. For samples where $n < 5$, the recommended Haldane correction factor for CV has been applied (Haldane 1955).

Measure	Sample	Max	Min	x	s	CV	R%	MI	F	t	p
Thickness at symphysis	Java	25.5	16.4	19.8	4.0	21.5	46.0	1.6			
	China	14.0	12.7	13.6	0.5	4.1	9.6	1.1	64.0	3.50	<0.01
Thickness at mental foramen	Java	28.0	16.3	20.0	4.8	25.2	58.5	1.7			
	China	16.4	14.7	15.5	0.7	4.5	10.9	1.1	53.1	2.07	<0.05
Thickness at m_2/m_3	Java	26.3	17.8	22.1	3.8	18.3	38.5	1.5			
	China	19.6	15.4	16.9	2.0	12.1	24.9	1.3	3.6	2.66	<0.05
Height at symphysis	Java	47.0	37.0	41.1	4.5	11.9	24.3	1.3			
	China	40.7	28.8	33.8	5.0	15.7	35.2	1.4	1.2	2.17	<0.05
Height at mental foramen	Java	48.0	25.6	37.9	7.5	19.8	59.1	1.9			
	China	34.0	25.2	27.6	3.7	14.1	31.9	1.3	4.1	2.81	<0.05
Height at m_2/m_3	Java	47.0	30.0	36.6	8.9	25.5	46.4	1.6			
	China	32.8	25.0	27.5	3.6	13.9	28.4	1.3	6.1	1.90	<0.05

mandibular data from primate species, which generally give CVs smaller than this (Gingerich 1974; Groves 1989). In the present study, for the six mandibular measures, the CVs for the sample of Asian fossils range from 15.8 through 25.0 (data from Weidenreich 1945; Sartono 1961: see Table 1). There appears to be a clear suggestion of multiple taxa present.

Though sample sizes are small they are the same or similar to those used to reach other conclusions about this material (Lovejoy 1970; Thorne and Wolpoff 1981; Groves 1989). When the Javanese and Chinese specimens are separated (Table 2), most variables show large

differences in CVs between them, the Javanese values possibly indicating that more than one species is represented in that sample. Four of the Chinese CV values also nudge up above 10.

It has also been shown (Alpagut, Andrews and Martin 1990) that when two populations of *Pongo* were compared using Student's t-tests, if 33% of those tests showed significance it was sufficient to avoid pooling the data. In addition, it was found using tooth metric data that 66% of a battery of such tests showed significance in the separation of *Australopithecus afarensis* and *A. africanus* (Alpagut, Andrews and Martin 1990).

Table 3: Comparison of fossil and extant hominoid R% values.

Calculations for Asian *H. erectus* on data from references cited in text. Data for all other taxa from Weidenreich (1945).

Measure	Java	China	Combined	AMH	Gorilla	Pongo	Pan
Thickness at symphysis	46.0	9.6	79.5	15.3	30.3	50.0	15.2
Thickness at mental foramen	58.5	10.9	75.9	15.9	33.8	32.8	16.1
Thickness at m_2/m_3	38.5	24.9	58.5	9.2	28.7	51.6	23.5
Height at symphysis	24.3	35.2	48.6	8.8	31.4	49.7	28.2
Height at mental foramen	59.1	31.9	69.7	13.1	23.3	16.5	3.4
Height at m_2/m_3	46.4	28.4	70.0	16.0	23.7	5.1	3.8

That is, significance in 2 out of every 3 tests was sufficient to separate two species. In the present study, data on mandibular metrics show that for the six tests performed, there are significant difference between the Chinese and Javanese samples (Table 2). This too supports a conclusion of separate species.

Range based statistics are now deemed to be important for comparative analyses of hominid variability (Blumenberg and Lloyd 1983; Groves 1989; Martin 1991). Range as percentage of mean (R%) and the maximum to minimum ratio (MI) in the Javanese sample are generally in excess of values for the Chinese fossils (Table 2). Even if purists insist that the Chinese sample comprises one species (Pope and Cronin 1984), these data suggest that multiple taxa are represented in the Javanese mandibles. Values such as 46.0 against 9.6, or 58.5 against 10.9 are surely suggestive of something.

It has been shown that if 21 out of 32 (66%) dental metrics are greater in range statistics than comparative hominoid samples, the null hypothesis of a single dimorphic species is falsified (Martin 1991). Table 3 shows that the combined pre-modern sample in the present analysis far exceeds anatomically modern humans (AMH) and other extant hominoids for all R% measures except one (that is, on 96% of comparisons). The Chinese sample only exceeds the extant taxa on 13 out of 24 comparisons (54%), but the Javanese sample exceeds the values for the hominoid taxa on 19 out of 24 measures (79%).

Thus using Martin's (1991) criterion, range based assessment of the mandibles rejects the null hypothesis, pointing to the presence of multiple taxa in Asia, and possibly even in Java itself.

SEXUAL DIMORPHISM AND ANAGENESIS

In the present analysis sexual dimorphism cannot be discounted as a cause of some of the variation present in the

small samples, but there are factors which suggest the presence of multiple hominid taxa. Variation appears to be greater than that shown by extant dimorphic hominoids. In order to support sexual dimorphism as a sufficient explanation for these data patterns, one would have to reject earlier limits for pre-modern variation (Oxnard 1987; Alpagut, Andrews and Martin 1990), and also imply that all females would have been recovered from China while mostly males were recovered from Java, or that sexual dimorphism in *H. erectus* was dramatically more pronounced in Java than it was in China.

Miller's analysis (Miller 1991) of sex ratio for gorillas showed maximum variation in CV values of 3.2 as he juggled his hypothetical sex ratios. If similar results were to be expected in my mandibular samples, it would hardly make much difference to my interpretations. Allowing for this much variation in the combined samples (Table 1) reduces the CV below 15.0 for only one of the six variables concerned.

That measure, height at symphysis, reduces its CV to 12.6. Even reducing the CVs of Table 1 by twice that much, still leaves 4 out of the 6 variables with CVs greater than 17.0. It does not appear that sex ratio factors affect the combined samples. For the Javanese samples by themselves, reductions in CV of similar magnitude to Miller's values leaves again 5 out of 6 measures showing values above 15.0.

It is worth noting that all of Miller's CV values for gorilla ECV range between 9.9 and 13.1. Elsewhere in his article Miller stresses that ECV is a volumetric variable and that to fully appreciate comparative linear CVs, a cube root of such a measure is required. This would give linear CVs for gorilla of the order of less than about 2.

Or if it is true that "a CV for a volumetric measurement may be up to three times as large as the average CV of its component linear dimensions" (Miller 1991:388),

we could expect linear CVs for gorilla of the order of about 4.3. These results certainly emphasise the large linear CV values of Javanese and combined samples in my study, and how they far exceed the linear CVs for gorillas generated by sexual dimorphism and sex ratios.

Similarly, if the differences are due to anagenesis, the single species has had to undergo change in half a million years or less, from being more morphologically variable than any extant hominoid, to one with nearly one third of that variability. Such a change would have occurred in company with significant change in mandibular size, counteracting a pattern previously established for the genus *Homo* (Chamberlain and Wood 1985). Alternatively and more parsimoniously, this analysis rejects the null hypothesis that the pre-modern Asian hominids belong to a single species.

If anagenesis is to explain the place of the Javanese mandibular sample, then it involves a very interesting evolutionary pathway. If *H. erectus* evolved in Africa as is generally thought, and if all the pre-modern Asian material does in fact belong to this taxon, then these data indicate that as the form moved through time and space, it did so in a vastly different way in Java from that revealed for other places.

In China the taxon changes morphologically to a smaller more gracile oro-facial form, while in Java it goes the other way, reverting to a form reminiscent of the robust australopithecines. This implies an evolutionary pathway that defies the general hominid pattern, taking on a mid-Pleistocene robusticity in a taxon which had lost that morphology in Africa over half a million years before.

MEASURES OF VARIATION

Miller (1991) warned that differences in CVs between samples may also result from temporal variation, geographical variation, sample choice, sex ratios and measurement techniques.

Sample choice becomes a factor I cannot control for. The set of Javanese mandibles is all we have. Future discoveries may show this to be a biased sample, but at the present time it is the complete collection. Groves (1989), Rightmire (1990) and others have continued to use it. My sample is no different.

Measurement techniques can be overcome by standardising the measuring instruments and the human measurers. I have controlled for discrepancies in measurement to the extent that I have used Weidenreich's (1945) original data. The same scientist (Weidenreich) using the same techniques gives a consistency to most of my numbers. Where other researchers have been called

upon to provide data I have chosen instances where they employed the same measures as those used by Weidenreich, in an attempt to control for any potential measurement discrepancies.

Variation may be caused by temporal and geographical differences in a manner consistent with anagenetic change. But as I have shown above, if that is the case, then something very atypical and interesting happened in Java as regards the standard evolutionary pathway of *Homo* specimens. If the Sangiran mandibles are a hyper-robust oddity as has been suggested by Pope and Cronin (1984), then they show another distinct oddity in the pattern of change from African origins. Either this or they constitute the descendants of a unique founder population that moved straight from Africa to Java without losing any of its characteristic australopithecine-like attributes.

VARIATION AND SPECIATION

Foley (1991) used a set of behavioural and ecological attributes in an attempt to predict the numbers of hominid species expected at various times in evolutionary history. This stimulates the question, can the variation in morphology discussed here be used to examine the number of species present in the fossil assemblages? From the sample of hominid species presented by Chamberlain and Wood (1985) it is possible to attain an estimate of the relationship between the number of hominid species present in an assemblage and the coefficient of variation in that assemblage.

When these data are presented graphically as a scattergram (Figure 1) they allow an interesting interpretation of the Asian data. For both the combined Asian sample and the Javanese material considered separately, thickness and height show high values and are located in the area of the scatter field represented by at least six species. There are a number of important points to be made about these data. Firstly, the variables are linear, in the manner discussed above in relation to the volumetric analysis of cranial capacity used by Miller. Thus we could expect, as I have demonstrated above contra Miller, that they will all be less than about 10 for an assemblage containing a single hominid species. In this graph, if that rough rule holds, there is a clear indication of multiple hominid species.

Secondly, while all CV values are above 10 for at least 2 species, these are conservative data. This is because Groves and others argue for, and appear to demonstrate, more than this number of species in these African and Old World assemblages. That is to say, I am taking here at face value the Chamberlain and Wood

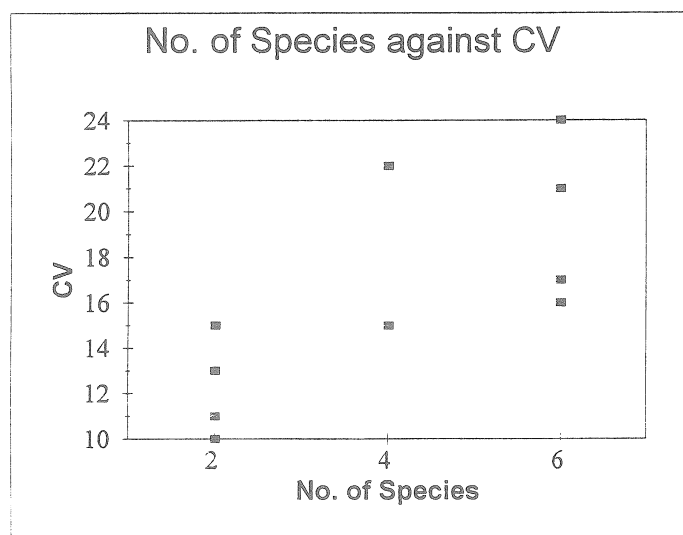


Figure 1: Scatterplot of Coefficient of Variation (CV) for various mandibular measures against number of species.

Using the samples listed in Chamberlain and Wood (1985), CVs were calculated for at least 2,3,4 and 6 species by cumulatively lumping their data. The combined Asian and Javanese CVs are in the high part of this range, suggesting an expectation of more than one species present in Asia generally, and Java in particular.

taxonomy of hominid species, where such standards as *Homo habilis* are accepted without question for these purposes as a single species.

Groves demonstrates that it is highly likely that there are in fact multiple species in many of these African collections from the Pliocene and Lower Pleistocene. This adds strength to my case, as I have taken as the baseline for this analysis, the CV values pertaining to what are in the mainstream seen as single species. If we consider that they may in fact constitute multiple species, then the case for even greater numbers of species in the Asian assemblages follows.

CONCLUSIONS

I have examined the single species null hypothesis for Asian pre-modern hominids by comparing six mandibular measures from samples of Javanese and Chinese fossils attributed by the dominant hypothesis to *H. erectus*. This analysis indicates that the hypothesis is found wanting. The study suggests that the Javanese sample is far too diverse to comply with the variation expected for a single hominid species.

In terms of hominid mandibular variation and the implications this has for the number of species present in an assemblage, the best quantitative expectation for the sample of Asian fossils is that it may represent at least six species. Realistically this will probably turn out to be slightly excessive. However the existence of multiple taxa, of some number between two and six appears to be reasonable. In this context designations such as *Meganthropus* prove useful and scientifically valid.

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