Early Holocene human skeletal remains from Cerca Grande, Lagoa Santa, Central Brazil, and the origins of the first Americans

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Abstract

We present the results of comparative multivariate morphological analyses based on nine skulls from Cerca Grande. The site is in the Lagoa Santa karst in Central Brazil, a key area for understanding the peopling of the Americas. The region has several archaeological sites with excellent preservation of late Pleistocene and early Holocene material culture and human skeletal remains. Stratigraphic association and direct dating of the Cerca Grande human skeletons place them definitely in the Early Holocene (*c*. 9000 BP uncalibrated). Principal components analysis and Mahalanobis distances reveal that these skeletons have no morphological affinities with present-day Native Americans or East Asians. These results agree with other studies and suggest that the skeletons may derive from a wave of migrants that entered the New World before the characteristic 'Mongoloid' morphology spread throughout East Asia.

Keywords

Peopling of the Americas; Paleoamericans; Paleoindian morphology; skeletal multivariate analyses.

Introduction

Human skeletal remains of terminal Pleistocene and early Holocene date are rare in the New World, especially in North America. In South America, the Lagoa Santa region is an exception. Since the 1830s tens of human skeletons have been found in the caves and rock shelters of this karstic region of Central Brazil. Recent archaeological research and AMS dating of human bones have supported an Early Holocene date for most of them (Araujo et al. 2003). This is allowing biological anthropologists to make robust inferences about

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Paleoindian within-population morphological variation, a hitherto unresolved problem (Jantz and Owsley 2001).

Since the pioneering work of Neves and Pucciarelli (1989, 1990, 1991) and Steele and Powell (1992, 1993), it is being increasingly recognized that the first Americans exhibited cranial characteristics that are rare or absent among later native New World populations (Jantz and Owsley, 2001). All South American isolated cranial specimens or series dated between 11,000 and 8000 BP so far assessed are morphologically similar to modern Australians and sub-Saharan Africans (Powell and Neves 1999). In contrast to most recent and modern Amerindians, the first South Americans have a strong predominance of long and narrow neurocrania, low and narrow faces, sub-nasal prognathism and low and wide orbits and noses. In North America the situation seems to be more complex. A few early skulls are similar to those of ancient South Americans (Neves and Meyer 1993; Neves et al. 1996, 1999a, 1999b; Jantz and Owsley 2001), but most are more similar to Southern Asians or Ainu-Polynesians (Steele and Powell 1992; Chatters et al. 1999; Brace et al. 2001; Jantz and Owsley 2001). Dental morphology also suggests biological heterogeneity, since both sundadonty and sinodonty (*sensu* Turner 1983) were present in the New World (Powell 1995; Powell and Neves 1998; Sutter 1997; Haydenblit 1996), a fact apparently unnoticed by Turner in his vast analysis of late dental prehistoric samples of the New World (Turner 1983; Greenberg et al. 1986).

Various scenarios for the peopling of the Americas have been proposed as a result. In order to advance some of the issues, we present here the results of a comparative multivariate morphological analysis based on nine Early Holocene individuals from Cerca Grande in the Lagoa Santa karst (Hurt and Blasi 1969).

The Lagoa Santa karst is near Belo Horizonte, the capital of the State of Minas Gerais. The area has several archaeological sites with very good preservation of late Pleistocene and early Holocene material culture and human remains, and is also a very important region for paleontological studies. Excavations in the area were first carried out by the Danish naturalist Peter W. Lund, who in 1842 reported a stratigraphic association between human and megafauna remains in Sumidouro Cave (Lund 1842). Wesley Hurt and one of us (OB) conducted the first professional archaeological excavations at Lagoa Santa in 1956. The primary aim was to investigate the co-occurrence of humans and megafauna. Excavation at Cerca Grande revealed Early Holocene human occupation, but nothing pointed to the coexistence of humans and extinct animals claimed by Peter Lund. In 1971–6 a French-Brazilian team led by Anette Laming-Emperaire carried out intensive archaeological investigations at Lagoa Santa (Laming-Emperaire et al. 1975). At Lapa Vermelha IV, bones and dung of an extinct ground sloth (*Catonyx cuvieri*) were found and dated to 9580 $\pm$ 200 BP (GIF 3208), while a human skeleton nicknamed ‘Luzia’ by one of us (WAN) was dated to older than 11,000 BP (Laming-Emperaire 1979; Prous 2001). These findings supported indirectly the co-occurrence of humans and extinct megafauna in Lagoa Santa.

In 2000, a long-term paleoanthropological project was initiated in the region co-ordinated by one of us (WAN). This project has already demonstrated that humans and megafauna really were contemporary in Lagoa Santa (Piló and Neves 2003), and has generated a refined chronology for human skeletal remains uncovered over the last 150 years.

Cerca Grande: chronology of the human occupation

Cerca Grande is the largest limestone outcrop within the Lagoa Santa karst. Lund carried out the first excavation in 1836 (Paula Couto 1950; Piló 2002), generating an important paleontological collection. He was also the first to describe the impressive prehistoric paintings present on the walls of Cerca Grande. In 1956 Hurt and Blasi conducted controlled archaeological excavations in seven different rock shelters at Cerca Grande and produced the first radiocarbon dates for the Lagoa Santa region. The dates supported Lund's assertion that humans were present in the area at least since the Terminal Pleistocene/Early Holocene (Hurt 1960, 1964; Hurt and Blasi 1969). Their excavations in Cerca Grande rock shelter 2 uncovered four very fragmented human skeletons. Rock shelter 5 yielded five human skeletons, one very fragmented. Rock shelter 6 produced eleven burials, although much of the large original burial area had already been destroyed by mining activities. Rock shelter 7 produced only one human burial (Hurt and Blasi 1969). All the burials were similar: the graves were very shallow (maximum 60cm in depth), and the bodies were hyper-flexed. Few funerary goods were present, and small stone slabs surrounded and covered the graves (Hurt and Blasi 1969). As Prous (1991) has emphasized, this is the regular funerary pattern found in the late Paleoindian sites of Lagoa Santa.

Radiocarbon assays for Cerca Grande are listed in Table 1. Layers 2/3 and 6/7 at rock shelter 6 are associated with the human burials, while the AMS dates are for bone collagen from the human skeletons. Unfortunately, six of the eight human bone samples sent to Beta Analytic did not contain collagen. The wood charcoal sample from rock shelter 7 is associated with the single burial from this site.

The associated lithic industry supports an Early Holocene date. It is composed predominantly of quartz crystal flakes, of which only a few exhibit a deliberately fabricated form or retouched edges. These include a few barbed arrow points, square-stemmed arrow points, endscrapers, semi-lunar scrapers or 'spokeshaves', triangular scrapers and ovoid scrapers. A few were also made of jasper. Pitted hammerstones (*quebra-cocos*) are also common. Bone artefacts are relatively rare and include bird bone projectile points. In sum, the industry is very similar to other assemblages dated to the Late Pleistocene/Early Holocene in Lagoa Santa (Kipnis 1998; Prous and Fogaça 1999).

Table 1 Uncalibrated radiocarbon dates ($\pm 1\sigma$) for the early occupation at Cerca Grande. P = Applied Center for Archaeology, University of Pennsylvania

Site	*Level*	*Date (BP)*	*Laboratory and no.*	*Material dated*	*Radiocarbon method*
CG 6	Burial 2	8230 ± 50	BETA 161666	Bone collagen	AMS
CG 6	Burial 3	8240 ± 40	BETA 161668	Bone collagen	AMS
CG 6	Level 2 and 3	9028 ± 120	P* 519	Charcoal	Standard
CG 6	Level 6 and 7	9720 ± 128	P* 521	Charcoal	Standard
CG 7	Burial 1	9130 ± 30	BETA 84446	Charcoal	Standard

We can thus safely ascribe an Early Holocene age to the burials at Cerca Grande. Apart from Santana do Riacho, a site 60km north of Cerca Grande where forty individuals of similar age were uncovered by Prous (1992–3; Neves et al. 2003), the human skeletal remains from Cerca Grande are so far the largest well-dated collection of late Paleoindians from a single locality available in the Americas.

Material and methods

Nine reasonably well-preserved skulls from Cerca Grande rock shelters 2, 5, 6 and 7 were measured following landmarks and conventions defined by Howells (1973). All were measured by the same physical anthropologist (WAN) to avoid inter-observer error. The material is housed in the Museu Nacional, Federal University of Rio de Janeiro, Rio de Janeiro. Table 2 gives basic information about them. The estimated age of > 8000 BP for MN 1319, MN 1332 and MN 1334 is based on the stratigraphy and associated cultural material. The age interval for MN 1325, MN 1353, MN 1357 and MN 1383 is based on radiocarbon dates bracketing the burials. In order to make this important information available to other scholars, raw metric data for each individual are listed in Table 3. There are many missing values due to imperfect preservation, but the Cerca Grande collection has the advantage, compared to other early American crania, of coming from a single local breeding population.

Principal components analysis and generalized Mahalanobis distances were used to compare the Cerca Grande specimens with a set of modern human reference samples taken from the Howells database (Howells 1973, 1989). We excluded some of the Howells populations because of small sample size (South and North Maori), extreme isolation (Andaman) or the large amounts of admixture in their origin (Philippines and Egypt).

To explore possible variations due to sex, we carried out the same analyses for three different databases: females, males, and the total series. Analyses were based on a consensus set of twenty-seven and forty-three variables for females and males respectively

Table 2 Basic information for the skulls from Cerca Grande included in the analysis

*Ref. number**	*Sex*	*Rock shelter*	*AMS date*
MN 1319	Male	5	> 8000[a]
MN 1325	Female	6	8230 – 9720[b]
MN 1332	Male	2	> 8000[a]
MN 1334	Male	5	> 8000[a]
MN 1353	Female	6	8230 – 9720[b]
MN 1355	Male	6	8240 ± 40[c]
MN 1357	Male	6	8230 – 9720[b]
MN 1383	Female	6	8230 – 9720[b]
MN 1388	Female	7	9130 ± 30[d]

Notes
MN = Museu Nacional, Rio de Janeiro.
a: estimated age; b: age interval; c: AMS date; d: stratigraphic age.

(indicated in Table 3) instead of Howells' original fifty-seven, in order to minimize the missing data for the Cerca Grande skulls. Missing values were replaced by multiple regression estimation (Sokal and Rohlf 1995), and the multiple regression equation for each replaced variable was computed from the complete modern database. The total database was obtained by pooling both sexes after standardizing all observations to *z*-scores within each sex (Williams-Blangero and Blangero 1989), and departing from the conservative data set of twenty-seven variables used above.

PCA was done separately for females, males, and the total series, using the covariance matrix rather than the correlation one. PCA scores were obtained for each of the most complete specimens (MN1388, MN1325 and MN1353 for females; MN1357 and MN1355 for males) and for the reference sample averages. Additionally, PCA scores for the average by sex and the total average were also obtained using complete as well as fragmentary specimens. The PCA for the total series was *z*-standardized to avoid sex differences, while for females and males the data were *Q*-standardized (Darroch and Mossiman 1985) to focus exclusively on shape differences. Double standardization (first to *z*-scores and then to *Q*-scores) was not used for the total series analysis, since it would result in a pooled within-group covariance matrix near singular. Removal of sex differences is also an alternative way to explore pure shape differences, since most size variation is related to sex.

Squared Mahalanobis distances were used as an alternative way to explore the morphological affinities of the Cerca Grande sample. Calculations were carried out for the female, male, and total series, using the most complete specimens of each sex (see above). Standardization procedures and number of variables used are equivalent to those used in the PCA analyses. Distances were visualized by means of multidimensional scaling.

Results and discussion

Figure 1 presents the first three PC scores for the female skulls and the female average, accounting for 53.9 per cent of the original information. Considering PC1 x PC2, MN1325 and MN1353 are outliers. MN1388 is strongly associated with sub-Saharan Africans, while MN1383 is intermediate between Australians and East Asians. The female average shows a strong relationship with Australians, particularly Tasmanians. Considering PC1 x PC3, MN1325 remains an outlier, while the other three females show a strong association with the Zulu series. The female average is clearly associated with the Zulu and Dogon, both African.

Figure 2 presents the first three PC scores for the male skulls and the male average, accounting for 46.3 per cent of the original information. Considering PC1 x PC2, MN1357 is an outlier beyond the Africans and Australians. MN1355 has a strong affinity with Tolai, Easter Island and Australia. The male average is closest to the Teita series from Africa, and then to the Australians. Considering PC1 and PC3, both MN1355 and MN1357 are strongly associated with Africans and Australians, also true for the male average which is closest to Tolai and Teita.

Figure 3 presents the first three PC scores for all skulls irrespective of sex and the total average calculated from the nine skulls, accounting for 45.6 per cent of the original information. The total average exhibits a strong relationship with Africans and

Table 3 Craniometric raw data (measurements in mm) for the nine Late Paleoindian skulls from Cerca Grande (landmarks and dimensions as in Howells, 1973)

		Females				*Males*				
		MN-1325	*MN-1353*	*MN-1383*	*MN-1388*	*MN-1319*	*MN-1332*	*MN-1334*	*MN-1355*	*MN-1357*
Glabello-occipital length	$GOL^{f,m,t}$	183	181	183	174				185	184
Nasio-occipital length	$NOL^{f,m,t}$	177	178	180	170				183	180
Basion-nasion length	*BNL*		96		100					
Basion-bregma height	*BBH*		127		131					
Maximum cranial breadth	$XCB^{f,m,t}$	129	134	129	130	133			127	124
Maximum frontal breadth	$XFB^{f,m,t}$	104	111	116	108	111			105	106
Bistephanic breadth	$STB^{m,t}$		105	115	107	106			102	97
Bizygomatic breadth	ZYB^{m}									128
Biauricular breadth	$AUB^{f,m,t}$	107	122	114	117	118			119	118
Minimum cranial breadth	$WCB^{m,t}$		65	65	71				69	65
Biasterionic breadth	$ASB^{f,m,t}$	97	103	115	104	106			112	101
Basion-prosthion length	*BPL*									
Nasion-prosthion height	NPH^{m}	52								63
Nasal height	NLH^{m}	41			44					49
Orbit height	$OBH^{f,m,t}$	34	33		34				33	32
Orbit breadth	OBB^{m}		39		38				39	40
Bijugal breadth	*JUB*		112		113					
Nasal breadth	NLB^{m}	24								24
Palate breadth, external	MAB^{m}	56								62
Mastoid height	MDH^{m}		24.5	21.5	27	21	22		23	22.5
Mastoid breadth	$MDB^{f,m,t}$	13	10	11.5	12	13	10		14	14.5
Bimaxillary breadth	*ZMB*		90		92					
Zygomaxillary subtense	*SSS*				17					
Bifrontal breadth	$FMB^{m,t}$		97	98	96			101	100	102
Nasio-frontal subtense	$NAS^{m,t}$		9	11	15			12	19	15
Biorbital breadth	EKB^{m}				96				100	

(*continued*)

Table 3 (continued)

		Females				Males				
		MN-1325	*MN-1353*	*MN-1383*	*MN-1388*	*MN-1319*	*MN-1332*	*MN-1334*	*MN-1355*	*MN-1357*
Dacryon subtense	*DKS*				12					
Interorbital breadth	DKB^{m}		20		20			23	26	23
Naso-dacryal subtense	*NDS*									
Simotic cord	*WNB*				8					7
Simotic subtense	*SIS*									
Malar length inferior	*IML*						37		38	
Malar length maximum	*XML*						51		51	
Malar subtense	*MLS*						9		11	
Cheek height	$WMH^{f.m}$	18	23		22		26		23	23
Supraorbital projection	$SOS^{f.m.t}$	5	7	6	8		8	8	5	5
Glabella projection	$GLS^{f.m.t}$	2	2	3	2			3	4	4
Foramen magnum length	*FOL*		32		32					
Frontal cord	$FRC^{f.m.t}$	107	108	110	108				111	112
Frontal subtense	$FRS^{f.m.t}$	28	27	25	26				23	26
Nasion-subtense fraction	$FRF^{f.m.t}$	47	42	44	44				46	50
Parietal cord	$PAC^{f.m}$	124	105		111				111	127
Parietal subtense	$PAS^{f.m}$	23	20		26				22	30
Bregma-subtense fraction	$PAF^{f.m}$	70	52		59				57	67
Occipital cord	$OCC^{f.m}$	94	105		92				98	92
Occipital subtense	$OCS^{f.m}$	29	33		24				27	27
Lambda-subtense fraction	$OCF^{f.m}$	48	49		45				34	49
Vertex radius	$VRR^{f.m.t}$	123	124	130	124	137			121	128
Nasion radius	$NAR^{f.m.t}$	95	90	92	94				94	95
Subspinale radius	*SSR*	94			90					99
Prosthion radius	*PRR*	100								107
Dacryon radius	*DKR*				84					86
Zygoorbitale radius	ZOR^{m}		82						82	84

(*continued*)

Table 3 (continued)

		Females				*Males*				
		MN-1325	*MN-1353*	*MN-1383*	*MN-1388*	*MN-1319*	*MN-1332*	*MN-1334*	*MN-1355*	*MN-1357*
Frontomalare radius	FMR^m		84	81	78	77			79	81
Ectoconchion radius	EKR^m				71				74	77
Zygomaxillare radius	ZMR^m		75		72				77	79
Molar alveolus radius	AVR	80								87

Note

Superscripts f, m, t denote variables considered to obtain the female, male or total average, respectively.

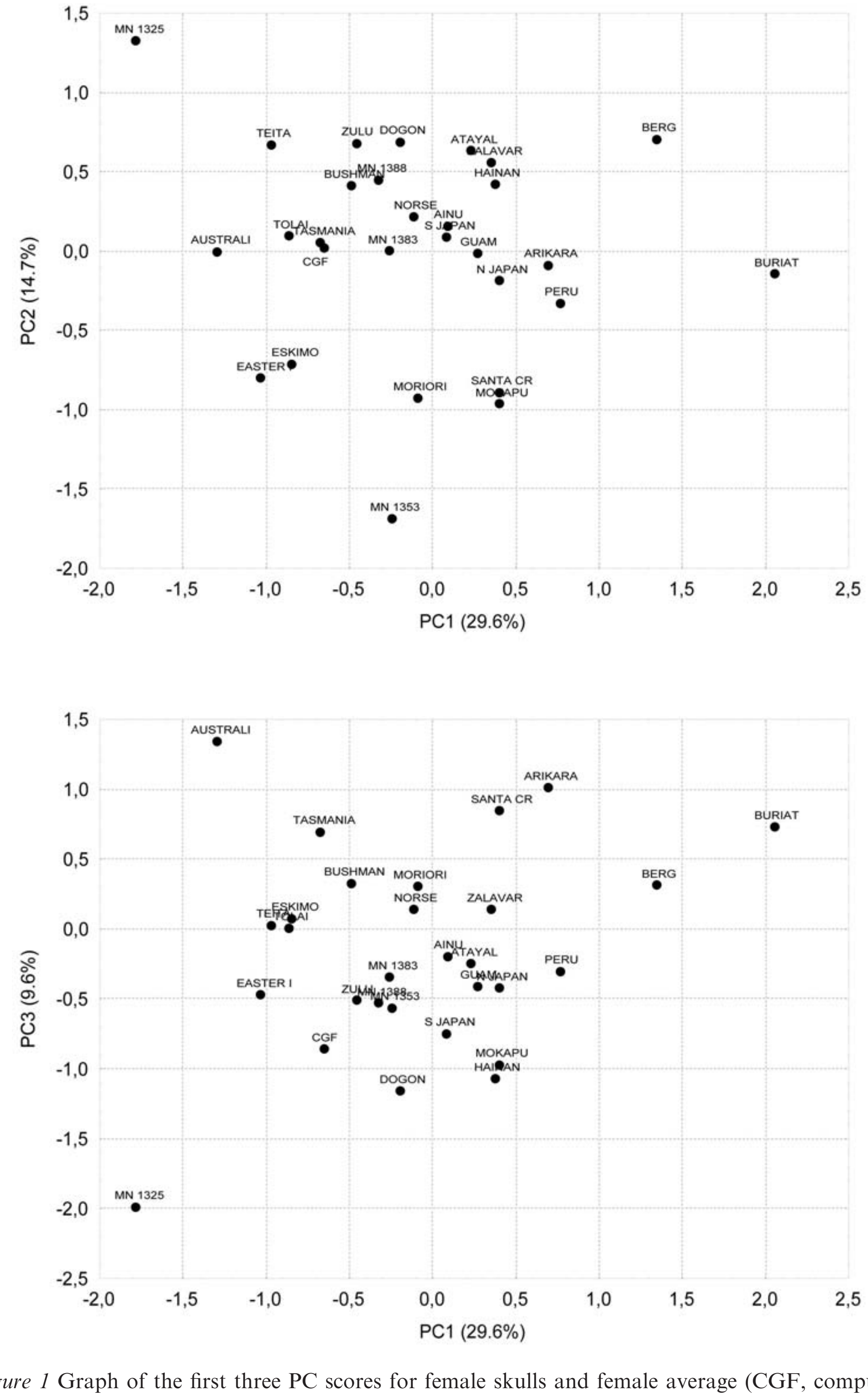

Figure 1 Graph of the first three PC scores for female skulls and female average (CGF, computed after the four skulls).

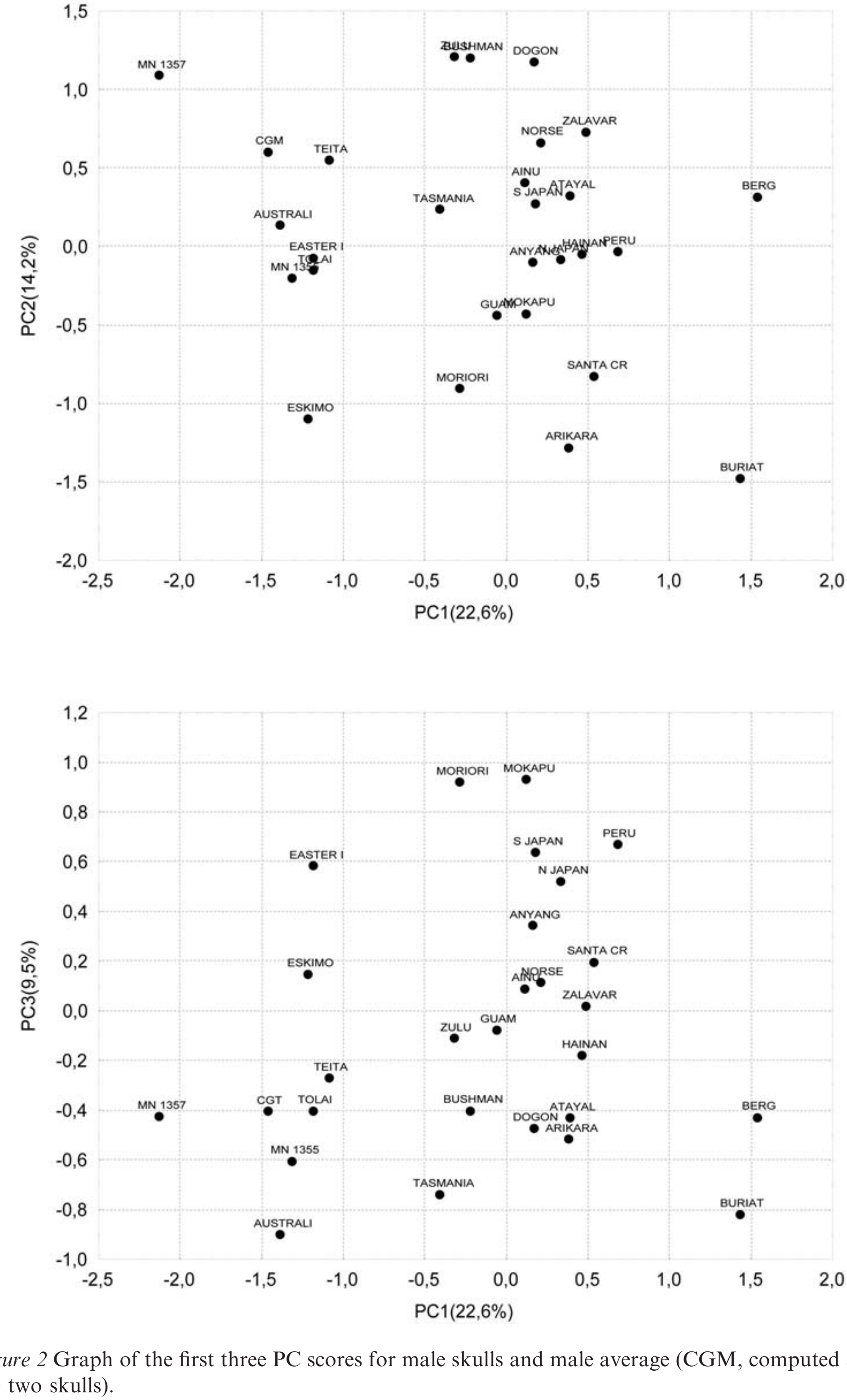

Figure 2 Graph of the first three PC scores for male skulls and male average (CGM, computed after the two skulls).

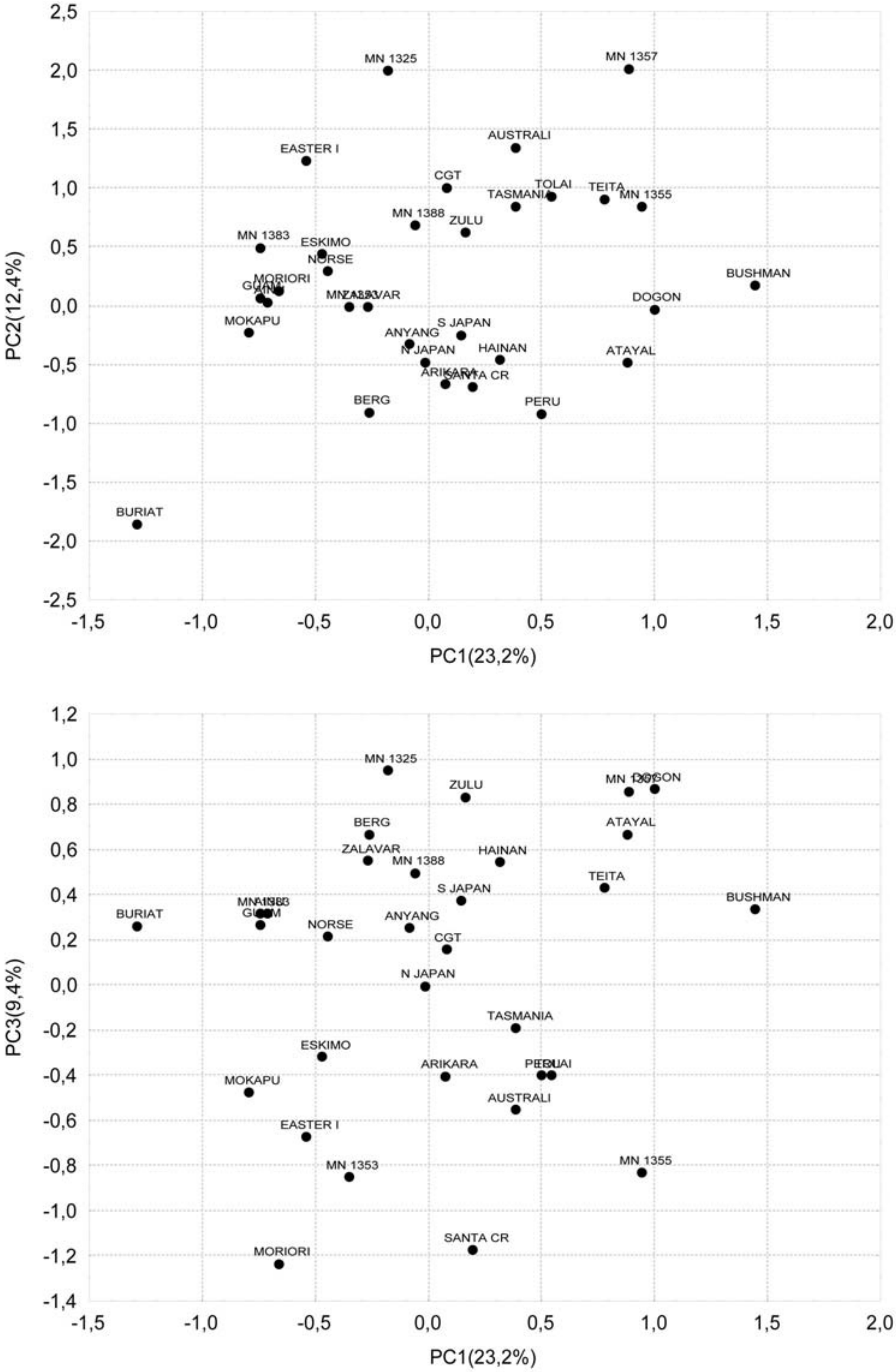

Figure 3 Graph of the first three PC scores for all skulls and total average (CGT, after the nine skulls).

Australians. Two individuals (MN1325, MN1357) are outliers beyond the Africans and Australians. MN1355 and MN1388 are well integrated with those two populations, while MN1383 and MN1353 cluster with some of the East Asians, Europeans, and Polynesians. Considering PC1 x PC3, the total average falls between South Japan, Anyang and North Japan. Two individuals (MN1357 and MN1325) are well integrated with the Africans, while four (MN1388, MN1383, MN1355 and MN1353) are scattered over the graph.

Table 4 presents the Mahalanobis distances between Cerca Grande and Howells' comparative samples. As can be seen, the Paleoindian females' closest series are Easter Island followed by Tolai. In the case of males, the nearest series are again Tolai and Easter Island, while in the case of the series as a whole, irrespective of sex, the closest are also Easter Island and Tolai, in that order. Easter Island is considered by several authors, including Howells (1973, 1989), the most 'Australo-Melanesian' population of Polynesia, in terms of morphology.

Multidimensional scaling was used to present a synthetic view of the morphological affinities among the series. The graphic results are not as impressive as the previous ones in terms of clarity. The Cerca Grande females (Fig. 4) show a clear affinity with Africans and Australians in Dimension 1. When Dimension 2 is taken into account, they show affinities

Table 4 Mahalanobis distances from Cerca Grande skulls to Howells' series. Bold numbers indicate the first three most similar populations

	Females	*Males*	*Total*
Ainu	30,993	57,304	24,202
Anyang	–	54,649	21,191
Arikara	46,316	70,076	40,347
Atayal	28,453	48,591	20,043
Australi	43,870	62,214	31,850
Berg	51,085	78,360	46,358
Buriat	70,922	105,587	67,539
Bushman	42,606	79,972	39,945
Dogon	35,272	72,926	27,316
Easter I	**16,861**	**44,515**	**13,597**
Eskimo	27,547	60,439	20,993
Guam	32,028	48,345	23,004
Hainan	30,407	58,916	23,875
Mokapu	28,695	55,042	25,216
Moriori	42,023	59,540	35,133
N Japan	29,291	64,683	25,648
Norse	42,914	62,275	35,444
Peru	45,062	62,822	36,436
S Japan	**25,114**	56,439	**19,359**
Santa Cr	56,828	62,723	42,297
Tasmania	38,071	55,087	26,058
Teita	32,976	**47,863**	23,380
Tolai	**24,479**	**39,998**	**14,248**
Zalavar	39,126	61,405	32,958
Zulu	28,513	55,357	21,033

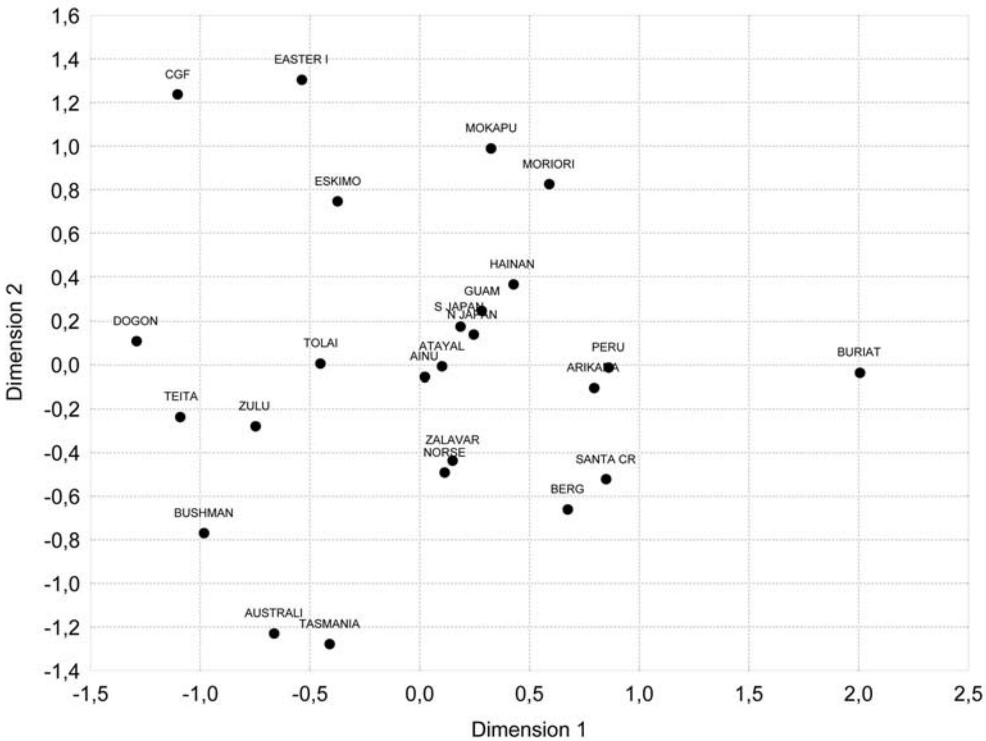

Figure 4 Graph of the multidimensional scaling obtained after the matrix of generalized distances for females.

with Polynesians (especially Easter Island). When both dimensions are considered together, Cerca Grande seems to occupy an outlier position in the north-western corner of the graph. The Cerca Grande males (Fig. 5) occupy a clear outlier position when Dimension 2 or both dimensions are considered, and a fairly central position if Dimension 1 alone is considered. When both sexes are taken together, the position is very similar to that of the females alone (Fig. 6).

The comparative morphological analysis carried out in this study thus strongly indicates that the Early Holocene inhabitants of the Cerca Grande rock shelters had long and narrow neurocrania, low, narrow and projecting faces, and low and relatively wide orbits and noses. These results corroborate other studies that suggest that the first South Americans had a predominant cranial morphology very different from that of modern Native Americans and East Asians (Neves and Pucciarelli 1989, 1990, 1991; Neves et al. 1996, 1998, 2003). The latter two have, in general, short and wide neurocrania, tall, wide and retracted faces, and tall and relatively narrow orbits and noses (Howells 1973, 1989, 1995). The cranial morphology of the early South Americans is similar to that found today, in greater frequency, among African and Australian aboriginal populations (Coon 1962; Howells 1973, 1989, 1995; Lahr 1996; Okumura 2002).

Recently, van Vark and Williams (2003) have argued, based on their work in Europe, that cranial morphological traits may be a poor indicator of ancestral–descendant

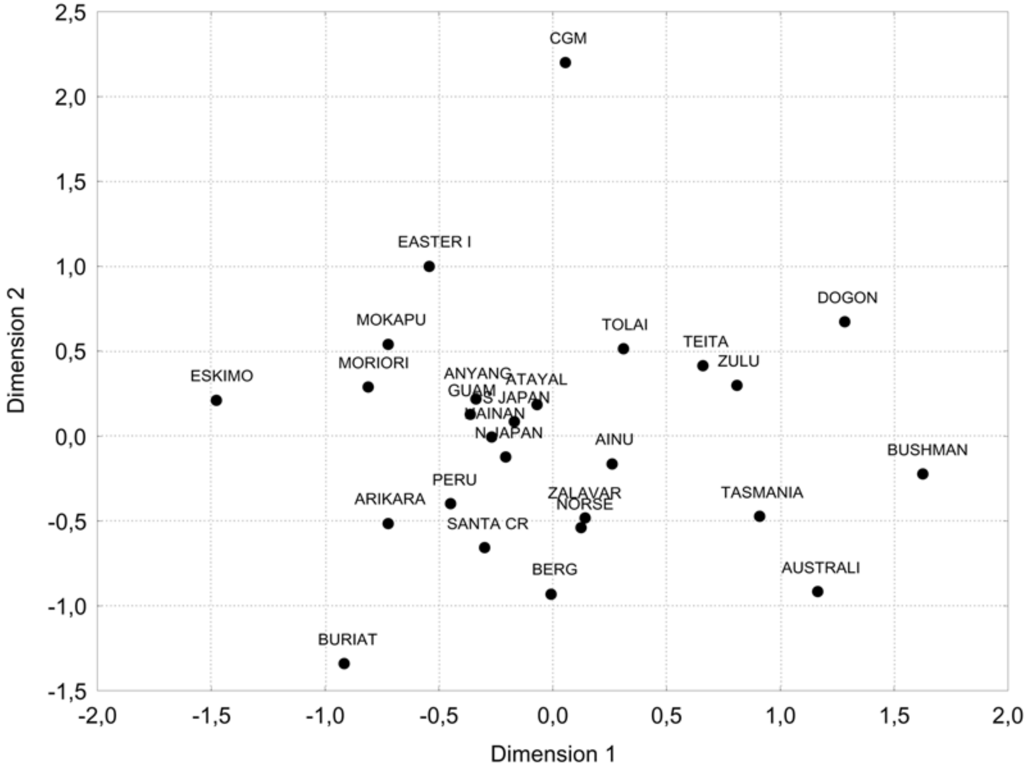

Figure 5 Graph of the multidimensional scaling analysis obtained after the matrix of generalized distances for males.

relationships between final Pleistocene populations and modern groups when isolated individuals are studied. They argue that affinities between isolated Paleoindian specimens and modern non-Amerindian populations is not strong evidence for the entry of two different biological populations into the New World, as argued by one of us (WAN) and Jantz and Owsley (2001). They also stated that modern European molecular and craniometric data are in contradiction, and that this is mainly caused by environmental effects acting on phenotypic variability.

In response, Jantz and Owsley (2003) noted that, in most cases, the number of variables used is an important factor to be considered before computing distances. They also demonstrated that, in general terms, molecular estimations of similarities are congruent with craniometric ones, both in Europe and in the New World. Van Vark and Williams' (2003) criticism is mainly focused on comparisons of single old specimens with modern samples. However, as we have demonstrated, divergence between Paleoindians and modern Amerindians has been also observed in large samples, not just in single specimens (see also González-José et al. 2001; Neves and Pucciarelli 1989, 1991; Neves et al. 2003).

We believe that information derived from comparative cranial morphological investigations can significantly advance our understanding of our recent biological history

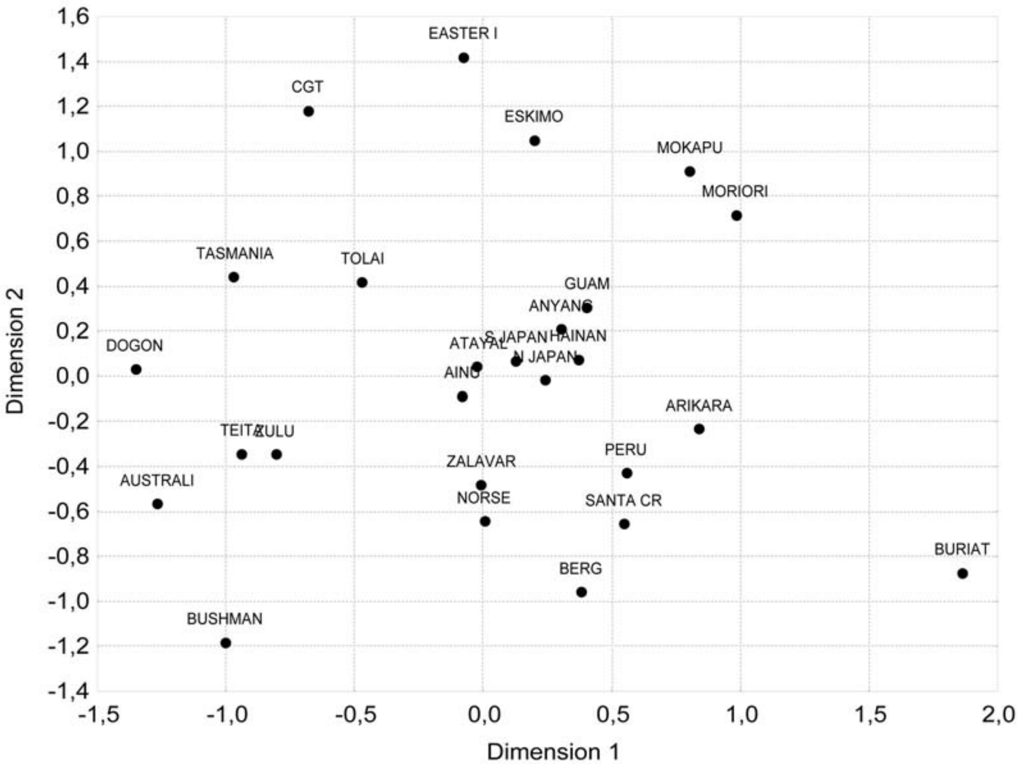

Figure 6 Graph of the multidimensional scaling analysis obtained after the matrix of generalized distances for all skulls.

(see Hanihara et al. 2003 for an outstanding example). Accordingly, we assume that elaborating on the cranial morphological differences between early and late Native Americans, and on how these differences can be understood in a broader geographic scale, can be valuable in advancing our knowledge of the settlement of the New World.

Conclusions: the origins of the first Americans

The concurrence of three independent sets of information has until recently favoured the 'Clovis model' of the settlement of the Americas: the absence of uncontested sites older than 11,400 BP uncalibrated; the sinodont character of the dentition of all prehistoric and modern Native Americans; and the fact that all DNA lineages in modern Amerindians can be traced back to populations currently located in north-east Asia.

Recently Dillehay (1997) has shown that humans were present in southern South America at least by 12,300 BP uncalibrated. There is very strong evidence of occupation in the Brazilian Amazon contemporary with Clovis (Roosevelt et al. 1996, 2002), and data have been accumulating since the mid-1970s suggesting a final Pleistocene (*c*. 12,000 BP uncalibrated) human colonization of central Brazil (Kipnis 1998). These archaeological findings have questioned the heuristic utility of the Clovis model, suggesting an earlier human entry, although not necessarily much earlier than Clovis (Roosevelt et al. 2002).

At the same time some physical anthropologists, working quite independently, demonstrated that the idea first suggested by Turner (1983; Greenberg et al. 1986) that all Native Americans, past and present, are sinodont is far from correct (Powell 1995; Powell and Neves 1998; Sutter 1997; Haydenblit 1996).

Molecular evidence from modern Native Americans is the only dataset that still does not refute the old model of the peopling of the New World by one small homogeneous group (Merriwether and Ferrell 1996; Merriwether 2002; Neel et al. 1994; Pena et al. 1995; Zegura et al. 2004). But as Templeton (2002) has elegantly demonstrated, the use of DNA lineages to infer population history can be very misleading if the number of genes analyzed is small, if the kind of inheritance of these genes is the same and if the raw information is naively assessed. The use of DNA lineage coalescence to infer the time of entry of *Homo sapiens* into the continent is also problematic (see Bonatto and Salzano (1997) and Silva et al. (2002) for estimates going well back into the Pleistocene). Recently, the use of molecular clocks in evolutionary studies has been severely challenged (Rodrigues-Telles et al. 2002), particularly those based on mtDNA (Kraytsberg et al. 2004). Furthermore, equating coalescence time with time of entry is questionable, because the possibility that the coalescent event occurred in Asia, before the immigrants arrived in the New World, cannot be ruled out.

Until the late 1980s the cranial morphology of the first Americans was not used systematically in modern times either to support or to refute the Clovis model. As we have noted elsewhere (Neves and Pucciarelli 1989, 1991), this is particularly curious when we consider the important role of comparative morphological studies in the examination of human origins and dispersion in other parts of the world. It may be explained by two facts (Owsley and Jantz 2001): first, few Late Pleistocene/Early Holocene specimens are available in North America; and, second, their comparative cranial morphology was not of interest because the 'Mongoloid' nature of the specimens was until recently taken for granted. (The term 'Mongoloid' is used here not, as in the past, as a fixed racial category, but as a supra-population unit of morphological affinity (SPUMA) joining late and recent Native Americans and north-east Asians). In South America the systematic use of comparative morphological studies had to wait until a regional school of old typologists was replaced by a new generation of physical anthropologists with a strong background in population biology and in quantitative methods of studying skeletal variation. When this new generation took over in the mid-1980s, the first extra-continental cranial morphological comparisons were carried out. The first exploratory exercise was that by Neves and Pucciarelli (1989).

The first comparative studies involving early South American specimens made it clear that they exhibited a very peculiar cranial morphology compared to later Amerindians (Neves and Pucciarelli 1989, 1990, 1991). Soon after these pioneering studies in South America, Steele and Powell (1992, 1993) demonstrated that the same could be said about certain early specimens from North America, a fact later confirmed by Neves and Meyer (1993).

As early as the mid-1990s, one of us (WAN) and associates started considering mainly the South American evidence, with regard to prevailing ideas about the occupation of the

New World. Munford et al. (1995) and Neves et al. (1996, 1999a) carried out extensive analyses of cranial morphological variation in South America from Early Holocene to historical times. Although the samples and the number of variables involved were smaller than desirable, a clear temporal pattern emerged: the Early Holocene specimens were morphologically similar to modern Australians and Africans, while later populations (post-dating 8000 BP) were similar to modern north-eastern Asians. Since there was no gradual transition between the two, the South American evidence suggested that the New World could have been settled by two very different Old World populations, both coming from north-eastern Asia.

For North America Powell and Neves (1999) demonstrated that the morphological transition from the Paleoindian to the Archaic period seems not to have occurred as abruptly as it did in South America, but was more gradual. It is however important to emphasize again that the North American Paleoindian sample is meagre. However, Brace et al. (2001) have shown that, even today, Native North American groups show a remarkable heterogeneity, which could reflect multiple migratory waves entering the New World.

Powell and Neves (1999) used population genetics to analyze the morphological transition in the Americas, and concluded that it could have occurred either through the entrance of two morphologically different populations from the Old World, or through *in situ* microevolution in the Americas. Choosing between these two scenarios requires a better understanding of the degree of genetic drift acting on the early population. González-José et al. (2002) also used population genetics to test three different models for the settlement of the Americas. Their results suggested that two different populations entered the New World from Asia, not three (as suggested by Greenberg et al. 1986) nor one (as suggested by DNA studies). Dixon (2001) has used technology to argue for the immigration of two very different populations from north-east Asia: a first wave of migrants using the atl-atl as their main weapon and a second wave using bows and arrows.

It is very important to make clear how widely the 'non-Mongoloid' morphology was distributed in the Americas, and how frequent this morphology was among local groups of Paleoindians. This is of paramount importance if we are to avoid two fallacies: (1) that this phenomenon is geographically restricted, representing a very local and specific adaptation; and (2) that what appears to be a pattern (the central tendency of a population) is actually the result of sampling outliers due to small sample sizes.

It is our opinion that the first potential fallacy has already been well explored and dismissed. Several recent studies have shown that the 'Australo-Melanesian' morphology was widespread in the New World, in places as distant and ecologically diverse as Southern Patagonia (Neves et al. 1999a), Central Brazil (Neves et al. 1998, 1999b), the Colombia Highlands (Neves and Pucciarelli 1989; Munford et al. 1995), Mexico (González-José et al. 2002) and Florida (Powell et al. 1999).

Regarding the second potential fallacy, the Lagoa Santa region is the only place in the Americas that allows us to explore within-population individual morphological variability among early American groups. We have already shown that, besides 'Luzia' (Neves et al. 1998), several late Paleoindian individuals from Santana do Riacho also exhibit a cranial morphology similar to modern Africans and Australians (Neves et al. 2003). The results presented in this paper based on the skeletons from Cerca Grande corroborate the idea that the peculiar morphology of these first South Americans represents the central tendency of this population, and is not just a misperception caused by a few 'aberrant' skulls, as suspected by Dillehay (2000) and Roosevelt et al. (2002).

To conclude, the studies of ancient human specimens so far carried out in South and North America are producing 'an emerging consensus that different populations were involved in the early peopling of [the Americas]' (Jantz and Owsley 2001:152). This scenario can easily be accommodated retaining Beringia as the main route into the New World, since it is already well recognized that late Pleistocene (and maybe early Holocene) Asians were very different in their cranial morphology from recent Asians, as shown by the Upper Cave and Liujiang specimens from China (Howells 1995; Kamminga and Wright 1988; Wright 1995; Neves and Pucciarelli 1998) and the Gua Gunung skeleton from Malaysia (Matsumura and Zuraina 1999). We concur with Jantz and Owsley (2001) that the appearance of the morphological pattern often termed 'Mongoloid' in Asia seems to be a recent phenomenon, and the expansion of people with this cranial morphology after the adoption of agriculture may have resulted in the replacement of much of the earlier variation present in that part of the world.

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Notes

This paper is dedicated to Wesley Hurt, *in memoriam*, for his immense contribution to the understanding of the Brazilian prehistoric societies, including those that inhabited Lagoa Santa when big beasts were still around.

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