

Human Skeletal Remains From Sabana de Bogotá, Colombia: A Case of Paleoamerican Morphology Late Survival in South America?

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ABSTRACT Human skeletal remains of the first Americans are scarce, especially in North America. In South America the situation is less dramatic. Two important archaeological regions have generated important collections that allow the analysis of the cranial morphological variation of the Early Americans: Lagoa Santa, Brazil, and Sabana de Bogotá, Colombia. Human crania from the former region have been studied by one of us (WAN) and collaborators, showing that the cranial morphology of the first South Americans was very different from that prevailing today in East Asia and among Native Americans. These results have allowed for proposing that the New World may have been colonized by two different biological populations in the final Pleistocene/early Holocene. In this study, 74 human skulls dated between 11.0 and 3.0 kyr, recovered in seven different sites of Sabana de Bogotá, Colombia, were compared with the world cra-

nia variation by different multivariate techniques: Principal Components Analysis, Multidimensional Scaling, and Cluster of Mahalanobis distance matrices. The Colombian skeletal remains were divided in two chronological subgroups: Paleocolombians (11.0–6.0 kyr) and Archaic Colombians (5.0–3.0 kyr). Both quantitative techniques generated convergent results: the Paleocolombians show remarkable similarities with Lagoa Santa and with modern Australo-Melanesians. Archaic Colombians exhibited the same morphological patterns and associations. These findings support our long-held proposition that the early American settlement may have involved two very distinct biological populations coming from Asia. On the other hand, they suggest the possibility of late survivals of the Paleoamerican pattern not restricted to isolated or marginal areas, as previously thought. *Am J Phys Anthropol* 133:1080–1098, 2007. ©2007 Wiley-Liss, Inc.

Until recently, the initial occupation of the New World was considered a very straight-forward scenario: Humans arrived in the Americas no earlier than 11.4 kyr; pioneer subsistence was solely based on specialized hunting of megafauna; all lithic industries were derived from Clovis; all migrants departed from Siberia; and only one major human biological stock was involved in the process.

However, several findings in archaeology and physical anthropology over the last two decades have significantly challenged this scenario. The existence of human cultural remains slightly older than or at least as old as Clovis in South America is now widely accepted by the international archaeological community (see Roosevelt et al., 1996; Dillehay, 1997; and Kipnis, 1998 for the best examples). The diet of the first South Americans was based on small and medium animals, complemented by a vast array of plant items, instead of megafauna (Prous, 1991; Roosevelt et al., 1996; Neves and Cornero, 1997; Kipnis, 1998, 2002; Piperno and Pearsall, 1998; Neves et al., 2004). The first lithic industries of South America were highly diversified, and most of them exhibited no direct relationship with Clovis (Bate, 1990; Politis, 1993; Borrero et al., 1998; Dillehay, 2000).

During this same period, molecular biology has also contributed vividly to the general discussion of who the first Americans were and when they arrived in the New World (see Schurr, 2004; and Zegura et al., 2004 for a review). However, even a brief survey of the literature shows that very conflicting results were generated by

the initial studies of the DNA of present day Native Americans. The results were especially conflicting when time of entry and number of migrations were estimated (Schurr, 2004; Zegura et al., 2004).

Based mostly on mtDNA and the Y chromosome, molecular biologists have suggested from one to as many as four discrete migrations to explain the genetic variation existing today in the New World. As to time of entry, dates as different as 12 and 35 kyr have been proposed. In the last 5 years, however, molecular biologists have tended to support a small number of migrations (1 or 2) and times of entry more compatible with the archaeological findings (Bonatto and Salzano, 1997; Schurr, 2004; but see Pereira et al., 2005 for an exception). They also

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agree that all lineages found in the Americas are clearly represented in the populations living today in Northeastern Asia.

The study of the skeletal biology of the first South, Central, and North Americans, but especially of the South Americans, also contributed significantly in the last 15 years to make the scenario of the early New World settlement more complex than had been previously thought. Neves and Pucciarelli (1989, 1990, 1991), and several later contributions based on a series of samples recovered from different sites in South and Central America, especially from Lagoa Santa (Neves and Pucciarelli, 1989, 1990, 1991; Neves et al., 1998, 2003, 2004, 2007; González-José et al., 2005; Neves and Hubbe, 2005) have called the attention to the astonishing morphological diversity in the Americas when the first settlers are considered.

It is now known that the cranial morphology of the first humans who entered the continent was very different from the pattern prevailing in later times and currently in the Americas and East Asia.¹ These findings suggest that the New World may have been colonized by two very different biological populations, both coming from Asia: one exhibiting a cranial morphology more similar to that of the first modern humans and still maintained in Africans and Australo-Melanesians today (Lahr, 1995), and another exhibiting a very distinct morphology (known as Mongoloid in the classic literature). Similar analyses of the few ancient human skulls available in North America have also suggested a dual occupation, although not as clear as in Central and South America (Powell, 1995; Brace et al., 2001; Jantz and Owsley, 2001).

If the Americas were settled by two very distinct human populations, what happened to the Paleoamericans? This is a crucial question because from the point of view of molecular biology, as mentioned before, present Native Americans are very homogeneous in terms of haplogroups (four haplogroups are shared by all present Native Americans, and a fifth one by all North American groups), and these haplogroups coalesce in only one mother population in East Asia, by the very end of the Pleistocene (Schurr, 2004).

In other words, while cranial morphology suggests the entrance of at least two very distinct human stocks into the New World, molecular markers tend to point to a single biological input. Since both categories of markers seem to respond to similar evolutionary forces (see Relethford, 2002; Roseman, 2004; Roseman and Weaver, 2004, demonstrating the neutral nature of morphological traits in humans), a certain degree of convergence would, in principle, be expected from both approaches.

In the beginning, those espousing the dual pattern of occupation suggested that the best scenario to explain this paradox would be one involving a major replacement of Paleoamericans by Amerindians during the Middle Holocene, with few or no genetic lineages being exchanged between both stocks (Munford et al., 1995; Neves et al., 1996, 1999). The few studies conducted so far on human cranial variation throughout time in South America as a whole have pointed in this direction (Munford et al., 1995; Neves et al., 1996, 1999). The transition between the Paleoamerican and the Amerindian mor-

phology was abrupt below the equator, and no late sample is known so far to exhibit the Paleoamerican pattern. However, a cautionary note is needed here. In both studies mentioned, most of the craniometric data was obtained from the literature, and several areas of South America were not covered. Most of the interior of South America is characterized by very acidic soils, and consequently, preservation of human remains is scant in vast areas of the subcontinent. Furthermore, samples were small in general, mainly in the case of Paleoamericans, in both studies.

In fact, the scenario may be much more complex than that envisaged by Neves and collaborators in the beginning of the 1990s. Lahr (1995), for instance, has suggested that Fuegians could represent a late survival of a generalized morphology in the tip of South America, since their cranial morphological pattern does not show a complete resemblance with that prevailing today in Northeastern Asia. More recently, González-José et al. (2003) have demonstrated that at least in another remote isolated area of the Americas, the tip of Baja California, the pristine Paleoamerican cranial pattern survived until the arrival of Spaniards in the region by ships in the 16th century. Accordingly, the understanding of the paradox posed by information coming from morphological and molecular markers could benefit substantially from an assessment of morphological change through time in several regions of South America (and eventually Central and North Americas).

However, few areas in South America allow for the study of cranial differentiation through time. Human remains of great antiquity (from the Paleoindian horizon) are rarely found, and in the few regions where they are found in significant numbers, comprehensive assessments of morphological changes in time cannot be carried out because archaic and late human skeletons are lacking. This is the case of Lagoa Santa, in Brazil. While early human skeletons abound in the region (Neves and Hubbe, 2005), archaic and late specimens are almost nonexistent. The region seems to have been mostly abandoned by humans from 7.5 to 2.5 kyr due to dry climatic conditions (Araujo et al., 2005).

In this study, the issue of Paleoamerican cranial pattern continuity is addressed by analyzing the patterns of human cranial variation through time at Sabana de Bogotá, Colombia, one of the few microregions of South America where human skeletal remains spanning the last 12,000 years are available.

THE ARCHAEOLOGICAL CONTEXT

The region of Sabana de Bogotá, Colombia (Fig. 1) is well known in the South American literature due to its high density of early archaeological sites, many of them presenting well-preserved burials. With the exception of Lagoa Santa, Brazil, this is the only other region in the continent where a reasonable number of early human skeletons has been found so far (Correal, 1990). Human skeletons from the archaic and late periods are also abundant in the local collections.

The prehistory of Sabana de Bogotá can be divided into three main periods: *Etapa Lítica* (Pre-ceramic period), running approximately from 12 to 3 rcyr, *Periodo Herrera* (Early Agriculture), covering the period from 3 kyr to 600 AD, and *Periodo Muisca* (Late Agriculture), from the 2nd century of our era up to the European conquest in the 16th century.

¹The morphological pattern that typifies the first South and Central Americas has been named Paleoamerican. This term was adopted to contrast the morphological definition from the culturally defined Paleoindians.



Fig. 1. Geographic location of the Colombian sites included in the study.

Sabana de Bogotá was first occupied by humans around 12 rcyr (Correal and van der Hammen, 1977; Contreras, 1989). The local lithic industry is described as a mix between Abriense and Tequendamiense artifacts. The former is characterized by very rough, simple unifacial instruments, with just one active border retouched by direct percussion. However, until the end of the Pleistocene, a series of more elaborated instruments, called Tequendamiense, were also well represented in the same deposits. The production of these more elaborated bifacial instruments involved detailed core preparation and fine retouching by pressure. They tend to decrease in importance toward the beginning of the Holocene. By 7.0 kyr, these finely elaborated instruments disappeared completely in the local archaeological record (Correal and van der Hammen, 1977; Botiva, 1989).

As the Abriense instruments became predominant in the local material culture, the use of bone and wood as raw material for tool manufacturing increased significantly. Concave scrapers became especially popular in the lithic assemblage, indicating frequent activities related to the processing of wood (Correal and van der Hammen, 1977; Botiva, 1989; Groot, 1992).

Around 5.0 kyr, the settlement-subsistence pattern at Sabana de Bogotá changed significantly as hunter-gathering was supplemented, although modestly, by cultivation of tubers (Correal and Pinto, 1983; Ardila, 1984; Correal, 1990; Peña, 1991; Groot, 1992, 1995). Rock-shelters discontinued being the preferred loci for the establishment of habitation sites. The new sites were then located in terraces, demanding the construction of simple hive-like houses (Correal, 1990; Peña, 1991; Groot, 1992, 1995).

For the first time, stone tools related to the cultivation and processing of tubers (mortars for instance) appeared in the local material culture. The local groups also started an active exchange with those settled in the Magdalena River Valley, located west of the Sabana (van der Hammen, 1988; Contreras, 1989; Correal, 1990). Most archaeologists operating at Sabana de Bogotá believe that the changes that occurred around 5.0 kyr were not triggered by the arrival at Sabana of a new human population (Botiva, 1989).

The local scenario changed significantly again circa 3.0 kyr with the appearance of the Herrera ceramic tradition in the region. According to several authors (for examples see Ardila, 1984; Correal, 1990; Peña, 1991), only from this time onward did agriculture become a major subsistence strategy in the Sabana. The occurrence of sites with Abriense tools associated with those of the Herrera tradition is not uncommon during this period (Correal and Pinto, 1983; Contreras, 1989; Peña, 1991). Most local archaeologists believe that ceramic and full-blown agriculture were both introduced in the region from the neighboring Magdalena River basin.

When the Europeans arrived in the region in the 16th century, Sabana de Bogotá was completely dominated by groups of the Muisca culture. They were responsible for the introduction of terracing agriculture in the area and apparently completely replaced the groups of the Herrera culture after their establishment at Sabana around the 3rd century AD. While the former Herrera agriculturalists relied on small-scale cultivation of maize and potato, the Muisca developed advanced strategies for the intensive cultivation of several different cultigens, including maize (the most important one), beans, potatoes, and squash. They were also capable of using all available land in the surroundings as cultivation fields, independent of the altitude.

A few descriptive analyses of the human cranial morphology carried out so far at Sabana de Bogotá by one of us (GC) have suggested a long biological continuity from 12 to 3 rcyr. Accordingly, the local cranial morphological pattern changed significantly and abruptly only with the arrival of the Herrera groups in the region. Rodríguez (2001) disagrees with this view and suggests that cranial morphology in the region remained the same even during the late ceramic periods (Herrera and Muisca). The biological continuity between 12 and 3 kyr (i.e. until the arrival of the Herrera culture) will be tested here. However, since Herrera material was not inserted in this study, the possible biological continuity after the arrival of the Herrera group will not be assessed.

MATERIALS AND METHODS

The 74 human specimens (33 males, 41 females) used in this work come from seven different archaeological sites of Sabana de Bogotá: Sueva 1, Guavio 1, Checua, Tequendama 1 and 2, Chia 3, Vista Hermosa, and Aguazuque (Fig. 1). These sites were excavated during the last three decades of the 20th century. With exception of Chia III and Checua, they were all excavated by one of us (GC). Table 1 presents the chronology of the seven sites. They range from ~11.0–3.0 rcyr. Only pre-Herrera human skeletons were included in the analyses. Table A1 presents the antiquity assumed for each specimen, in accordance with their position in the stratigraphic sequence and/or direct AMS dating. A conservative strategy was adopted to define this chronology,

TABLE 1. Chronology of the Colombian sites

Site	Males	Females	Dates ^a (rcyr BP)	Reference
Sueva	–	1	10,090 ± 90	Correal (1979)
Guavio I	1	–	9,360 ± 45	Correal (1990)
Tequendama	5	4	9,740 ± 135	Correal and van der Hammen (1977)
Checua	1	3	7,800 ± 60 to 6,800 ± 40	Groot (1992)
Chia III	–	2	5,040 ± 100	Ardila (1984)
Aguazuque	22	28	5,030 ± 40	Correal (1990)
Vistahermosa	2	5	3,410 ± 35 to 3,135 ± 35	Correal (1990)

^a Laboratory references are presented in Appendix B.

since few individuals were directly dated. Taking into account the importance of this material in the context of human evolution in the Americas, a short description of each site is presented in Appendix B.

Thirty-one linear variables were used to describe each specimen. Variable definitions followed Howells' standards, and all measurements were done by one of us (WAN). The craniometric measurements taken and their codes can be found on Tables A2 (males) and A3 (females). Taking into account their chronology, the skulls from Colombia were divided in two subgroups: an early one dated between 10 and 6 rcyr (Paleocolombians), and a late one dated between 5 and 2.7 rcyr (Archaic Colombians).

As comparative reference samples, 18 series measured by Howells (1973, 1989, 1995), representing six worldwide regions were included in the analyses. A Paleoamerican series of 81 skulls from Lagoa Santa, Brazil (measured by WAN; Neves and Hubbe, 2005) was also used as an additional comparative sample.

The morphological affinities of the Colombian series were assessed through four different multivariate approaches. The first consisted in Principal Component (PC) analysis of the sample centroids. In this case, the PCs were extracted from the covariance matrix constructed from the population means. Although this kind of analysis is usually considered problematic because it does not consider the intrapopulation variation, we chose to present it here as a complement to the other methods for three reasons: (1) It considers the totality of skulls in the Colombian samples (i.e. even skulls in which only a few measurements were possible to be taken contribute to the centroid); (2) there is no missing value replacement, and thus no value in the analysis is estimated; and (3) the variance matrix in this case would mainly represent the interpopulation variation, so that each PC maximizes the differences between the groups. Although this strategy does not contribute to the understanding of the evolutionary processes shaping skull morphology, it helps to contextualize the morphological relationships between groups, especially when worldwide cranial variation is considered.

The second multivariate approach applied was PCs analysis on the best-preserved individuals (18 males and 32 females). The PCs were extracted from the total covariance matrix, which in this case considered the intrapopulation variation as well as the interpopulation variation. After the extraction of the PCs, the centroid of each series was calculated as the mean factor score of its individuals.

The last two approaches were based on the Mahalanobis Distance between the groups. In the first, the distance matrix was graphically expressed through Multidimensional Scaling, while in the second it was used to construct clusters, using Ward's method. These approaches

complement the previous ones, since the Mahalanobis Distance is based on pooled within-samples covariance matrices (only intrapopulation variation included), and considers the differences between all the variables, instead of the most significant ones as in PCs analyses.

Thus, the four approaches presented here explore the morphological affinities between the series from different standpoints, and their results must be seen as complementary.

In all analyses, males and females were treated separately. For each sex, analyses were done on the raw database and on size-corrected measurements. However, since there is no significant difference in the results obtained for size and shape and shape-only data, only the latter will be presented here. The measurements were corrected for size, based on the strategy suggested by Darroch and Mosiman (1985). Accordingly, the values of each variable of one specimen were divided by the geometric mean of all variables of the same individual. In the first approach, the size correction was done on the mean vector of each population. For the approaches based on the individuals (PCs of the individuals and Mahalanobis Distances), eventual missing data (7.53% for males and 8.57% for females) were replaced by multiple regression applied to the mean of the variable involved for all series. In these cases, size correction was performed only after the missing values were replaced.

Preliminary analysis of the Colombian material (not shown here) demonstrated that one male individual (AZ45833) was an outlier to the archaic Colombian population, and thus was removed from the comparative analyses described earlier. However, to see the morphological affinities of this individual in relation to the American morphological variability, it was inserted together with the other Colombian individuals in a PC analysis, considering the individual dispersion of Paleoamericans, Amerindians, East Asians, and Australo-Melanesians. The last two groups were inserted in the analysis due to their close relation to Amerindians and Paleoamericans, respectively (Neves and Hubbe, 2005). Since the preliminary analysis showed that its outlier condition was not due to misclassified sex, its morphological affinities were tested considering only males.

RESULTS

Figure 2 shows the morphological affinities between the male series, described by the first two PCs extracted from the series means. The PCs account for 56.9% of the information contained in the original variables. As can be seen, there is a strong affinity between Paleocolombians, Archaic Colombians, Lagoa Santa and Easter Island. When the first PC, which alone explains more than 40% of the original variation, is considered, the Colombian series present values similar to Australo-Mela-

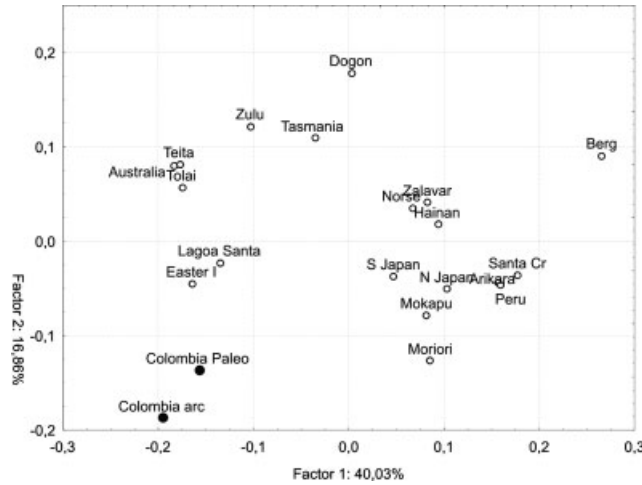


Fig. 2. Morphological affinities among the male centroids (calculated as the mean of the individual measurements) seen through the first two principal components (PC). The percentages associated to each axis are the amount of the original information condensed by each PC. In this analysis, series occupying high positive values along PC1 present wide and short skulls, high orbits and noses, large bregma-subtense fractions and wide bijugal distances, while series with high positive values along PC2 have wide and low faces, large occipitals, projected nasal regions and small frontomale radii.

nesians and Africans. East Asians and Amerindians occupy an opposite position in this axis. Table 2 lists the correlations between the first two PCs and the original variables. As can be seen, the first PC presents high positive correlations ($r > 0.55$; $P < 0.01$) with cranial breadth (XCB, AUB, XFB, and ASB), bregma subtense fraction (FRF), nasal and orbit height (OBH and NLH) and bijugal breadth (JUB). The first PC also presents high negative correlations ($r < -0.55$; $P < 0.01$) with cranial length (PAC and GOL) and malar length, inferior (IML). The second PC shows high positive correlations ($r > 0.55$; $P < 0.01$) with upper facial, orbital, nasal and interorbital breadth (FMB, OBB, NLB, and DKB) and with nasion subtense (NAS), and high negative correlations ($r < -0.55$; $P < 0.01$) with frontomale radius (FMR), facial height (WMH, NPH, and NLH) and occipital length (OCC and OCF).

The biological affinities detected among the female centroids, according to the first two PCs (resuming 58.1% of the original variance) can be observed in Figure 3. There is a strong affinity among Paleocolombians, Archaic Colombians, Lagoa Santa, Australo-Melanesians, and Africans. Similar to the results obtained for males, in this analysis, the East Asian and Amerindian series appear well separated from the Colombians by the first PC. Correlations between the first two PCs and the original variables can be seen in Table 2. In this case, the first PC presents high positive correlations ($r > 0.55$; $P < 0.01$) with cranial breadth (XCB, AUB, XFB, and ASB), facial, nasal and orbit height (NPH, NLH, OBH) and with bijugal breadth (JUB). It also presents high negative correlations ($r < -0.55$; $P < 0.01$) with malar length, inferior (IML) and cranial length (PAC and GOL). The second PC shows high positive correlations ($r > 0.55$; $P < 0.01$) with cranial length (NOL, PAC and PAF) and high negative correlations ($r < -0.55$; $P < 0.01$) with maximum malar length (XML).

TABLE 2. Correlation between the first two Principal Components and the original variables used in the analyses based on sample centroids (calculated as population mean prior to PC extraction)

	Male shape alone		Female shape alone	
	PC 1	PC 2	PC 1	PC 2
GOL	-0.5848	-0.1882	-0.5664	0.5211
NOL	-0.4559	-0.1865	-0.4396	0.6009
XCB	0.9550	0.0887	0.9650	0.1357
XFB	0.8334	0.3440	0.8324	0.4095
AUB	0.8438	-0.3721	0.9045	-0.1331
ASB	0.6406	-0.0713	0.6043	0.5421
NPH	0.4764	-0.6325	0.6704	-0.2540
NLH	0.5835	-0.5821	0.6678	-0.3517
OBH	0.5646	-0.4018	0.6141	-0.2885
OBB	0.2565	0.5507	0.4009	-0.0535
JUB	0.5504	-0.0020	0.5520	-0.2301
NLB	-0.2971	0.5961	-0.3515	-0.1189
ZMB	-0.0344	-0.4079	0.3072	0.0576
FMB	-0.1853	0.6127	-0.1226	0.4085
NAS	0.2278	0.5995	0.0533	0.0171
DKB	0.1636	0.5924	-0.5288	0.3270
IML	-0.6350	0.2752	-0.6839	-0.4298
XML	-0.1046	-0.0648	-0.2510	-0.7240
MLS	0.0497	0.3019	-0.0916	-0.4686
WMH	0.3131	-0.7435	0.4627	-0.2614
FRC	0.2262	-0.3076	0.2230	0.3619
FRS	-0.1626	0.5356	-0.1918	0.5250
FRF	0.6396	-0.2237	0.5155	0.1758
PAC	-0.6866	0.0453	-0.5718	0.6416
PAS	-0.2921	-0.0784	-0.1949	0.3317
PAF	-0.3514	0.3129	-0.3713	0.5528
OCC	0.2708	-0.6500	0.3096	0.1486
OCS	-0.1885	-0.5037	0.0241	0.4228
OCF	0.1510	-0.6374	0.4588	-0.0317
NAR	-0.4680	-0.5412	-0.4255	-0.4154
FMR	-0.4798	-0.7528	-0.3668	-0.3502

The values in bold represent highest correlations for each PC ($r > 0.55$ or $r < -0.55$; $P < 0.01$).

The morphological affinities obtained for the first two PCs (resuming 33.9% of the original variation) extracted from the best preserved male individuals are shown in Figure 4. Although PCs were extracted from a matrix containing the individuals of each series, only the centroids are plotted in the graphs. In this analysis, there is a clear association between Paleocolombians, Archaic Colombians, Lagoa Santa, two Australo-Melanesian series (Australia and Tasmania), one African (Teita), and Easter Island. The East Asian and Amerindians series are separated from this cluster by the first PC. Table 3 presents the correlations between the PCs and the variables. The first PC presents high positive correlations ($r > 0.50$; $P < 0.0001$) with cranial breadth (XCB, AUB, XFB and ASB) and high negative correlations ($r < -0.50$; $P < 0.0001$) with parietal chord (PAC). The second PC shows high positive correlations ($r > 0.50$; $P < 0.0001$) with parietal length (PAC and PAF) and with maximum cranial breadth (XCB).

The morphological affinities derived from the best-preserved female specimens can be seen in Figure 5. The first two PCs here resume 35.4% of the original variation. Again, the two Colombian series appear in the same area of the morphospace, together with Lagoa Santa, Australo-Melanesians (Australia and Tasmania), Zulu (Africa), and Norse (Europe). Different from the previous analyses, the separation between this cluster and East Asians and Amerindians is not as pronounced.

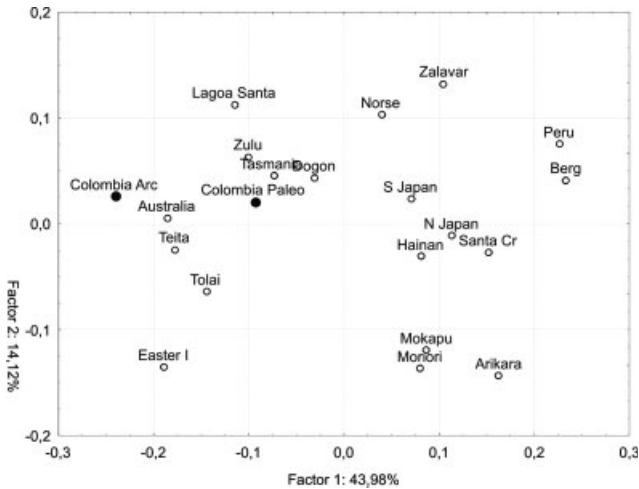


Fig. 3. Morphological affinities among the female centroids (calculated as the mean of the individual measurements) seen through the first two principal components (PC). The percentages associated to each axis are the amount of the original information condensed by each PC. In this analysis, series occupying high positive values along PC1 present wide and short skulls, high faces, large bijugal distances, and small malars, while series with high positive values along PC2 have long skulls and short malars.

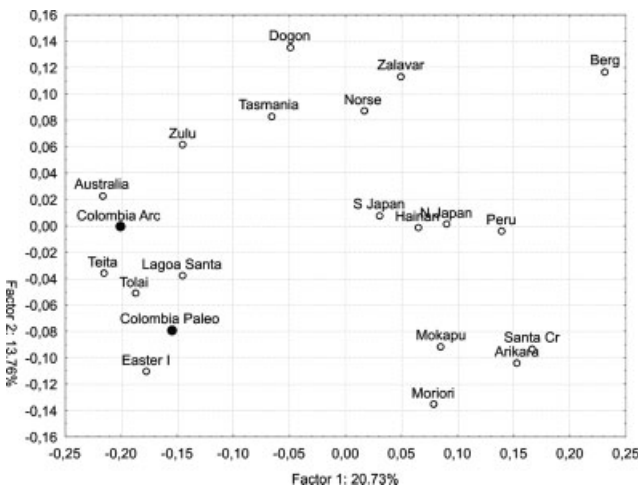


Fig. 4. Morphological affinities among the male centroids (calculated as the mean of the individual principal component scores) seen through the first two principal components (PC). The percentages associated to each axis are the amount of the original information condensed by each PC. In this analysis, series occupying high positive values along PC1 present wide skulls and short parietals, while series with high positive values along PC2 have long parietals and wide maximum skull breadths.

However, they still occupy opposite positions along the first and the second PCs. The correlations between PCs and variables for this analysis are listed in Table 3. The first PC presents high positive correlations ($r > 0.50$; $P < 0.0001$) with cranial breadths (XCB, AUB, and XFB) and high negative correlations ($r < -0.50$; $P < 0.0001$) with parietal chord (PAC). The second PC shows high positive correlations ($r > 0.50$; $P < 0.0001$) with cranial length (GOL and NOL).

TABLE 3. Correlation between the first two Principal Components and the original variables used in the analyses based on sample centroids (calculated as the mean of the individual component scores)

	Male shape alone		Female shape alone	
	PC 1	PC 2	PC 1	PC 2
GOL	-0.4555	0.2174	-0.3868	0.7769
NOL	-0.3901	0.2194	-0.3254	0.7966
XCB	0.8576	0.3845	0.8378	0.2547
XFB	0.6556	0.5530	0.6303	0.1904
AUB	0.7326	-0.0290	0.7476	-0.0212
ASB	0.5117	0.2216	0.4813	0.4427
NPH	0.3645	-0.2777	0.3592	-0.1530
NLH	0.3695	-0.2909	0.3988	-0.1083
OBH	0.3330	-0.1445	0.3700	0.0285
OBG	-0.0053	-0.0448	0.1210	-0.0249
JUB	0.1890	-0.2542	0.2400	-0.4047
NLB	-0.3209	-0.0351	-0.3175	-0.2436
ZMB	0.0728	-0.2878	0.1373	-0.2806
FMB	-0.1559	0.0495	-0.0593	-0.1376
NAS	-0.1493	-0.0746	-0.1953	-0.0858
DKB	-0.2212	0.0703	-0.2949	-0.2222
IML	-0.4428	-0.2408	-0.4143	-0.4019
XML	-0.1666	-0.3098	-0.1561	-0.4955
MLS	-0.1499	-0.2257	-0.2309	-0.4273
WMH	0.2293	-0.3905	0.2221	-0.2372
FRC	0.1063	0.2652	0.1543	0.3195
FRS	-0.1056	0.4853	-0.1202	0.2081
FRF	0.1685	0.0295	0.0905	0.0001
PAC	-0.5296	0.6687	-0.5692	0.4312
PAS	-0.2306	0.4906	-0.3266	0.0215
PAF	-0.3034	0.6073	-0.4966	0.1873
OCC	0.2952	-0.2318	0.3799	0.4406
OCS	-0.0078	-0.1929	0.0896	0.4854
OCF	0.2550	-0.3662	0.4061	0.0533
NAR	-0.3273	-0.2991	-0.2199	-0.0635
FMR	-0.2137	-0.2820	-0.0992	-0.0210

The values in bold represent highest correlations for each PC ($r > 0.50$ or $r < -0.50$; $P < 0.0001$).

The Multidimensional Scaling of the distance matrix² for males generated the graph depicted in Figure 6. As seen in the previous analyses, the Colombian series present a close association with the Paleoindian sample. However, the three South American samples appear isolated from the other series in the first dimension, and intermediate to Australo-Melanesians/Africans and Amerindians/East Asians in the second dimension. The results obtained for the female data can be seen in Figure 7. Again, the Colombian series appear close to Lagoa Santa and, in this case, to Easter Island. The South American series also appear isolated from the remaining ones, but this time they appear clearly closer to Australo-Melanesians than to East Asians or Amerindians.

Since the relation of the two Colombian series and Lagoa Santa with the remaining series is not clear in the Multidimensional Scalings (especially for males), the distance matrices were also represented by Clusters. The dendrogram generated for males is illustrated in Figure 8. As can be seen, both Colombian series share a cluster with Lagoa Santa, and in a second level, the three samples are clearly grouped with the Australian and African comparative samples. On the other hand, recent Amerindian comparative samples (Arikara, Santa Cruz, and Peru) are clearly associated with East Asians, as expected. As to the females, the only difference observed

²Distance matrices are available upon request to the authors.

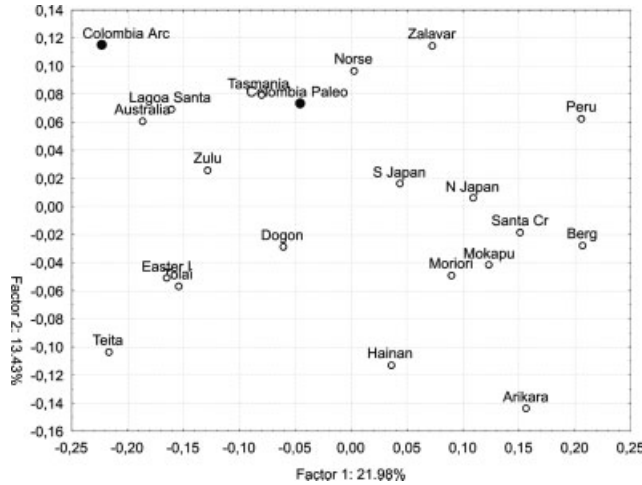


Fig. 5. Morphological affinities among the female centroids (calculated as the mean of the individual principal components scores) seen through the first two principal components (PC). The percentages associated to each axis are the amount of the original information condensed by each PC. In this analysis, series occupying high positive values along PC1 present wide skulls and short parietals, while series with high positive values along PC2 have long skulls.

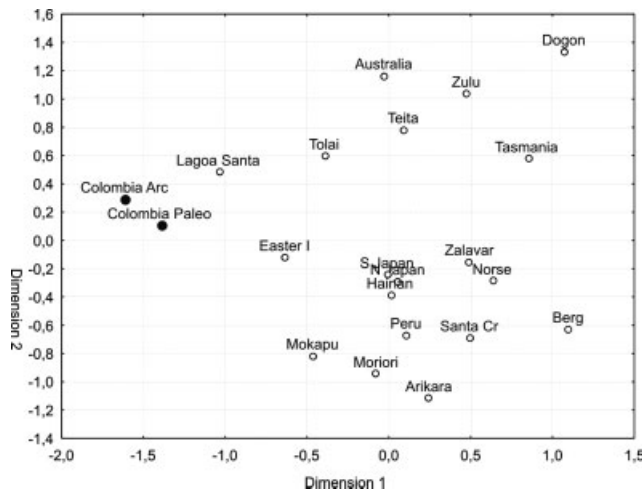


Fig. 6. Morphological affinities among the male series derived from Multidimensional Scaling of the Mahalanobis Distances matrix.

(Fig. 9) in the pattern of association resulting from the clustering procedure is the fact that Easter Island appears now integrated in the cluster formed by Colombians, Lagoa Santa, Australians, and Africans.

It is important to note that in all analyses carried out here, but mainly in the case of the clusters, the comparative samples are always grouped by a geographic logic, mimicking the pattern also found by Howells (1973, 1989, 1995) in his seminal studies. This attests to the robustness of the quantitative treatment adopted in this work.

The morphological associations of the outlier individual (AZ45833) tested through PCs analysis of the individual dispersion of some series is illustrated in Figure 10. The graph shows the difference between Paleoamericans and Australo-Melanesians on the one hand and East Asians and Amerindians on the other. As expected,

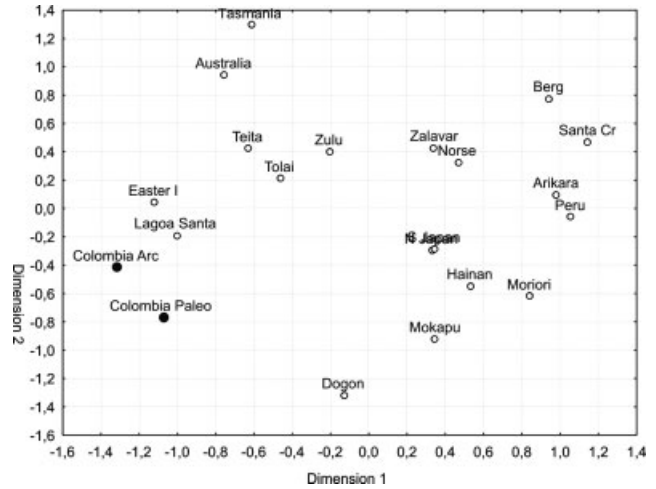


Fig. 7. Morphological affinities among the female series derived from Multidimensional Scaling of the Mahalanobis Distances matrix.

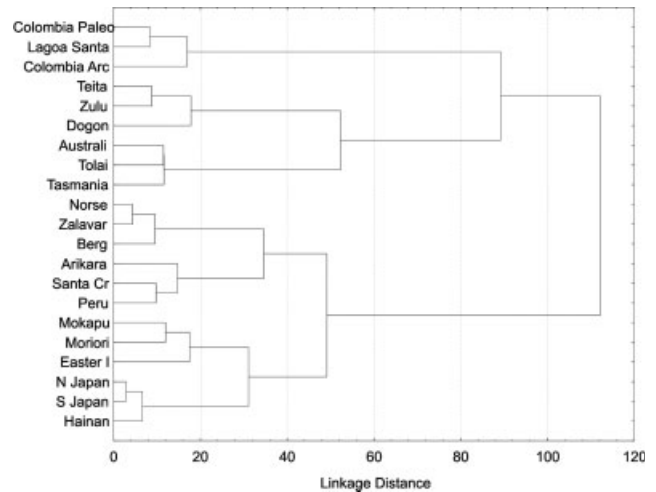


Fig. 8. Morphological affinities among the male series derived from Cluster Analysis (Ward's method) based on Mahalanobis Distances matrix.

all but two Colombian skulls can be found within the Paleoamerican/Australo-Melanesian dispersion. Specimen AZ45825 appears outside the dispersion, but did not emerge as an outlier in the preliminary analysis. AZ45833, on the other hand, is clearly an outlier, and was not inserted in the previous analysis. His outlier nature derives from a rounder neurocranium, a wider face, and higher orbits. Also, the specimen was found in the upper part of the archaeological sequence in Aguazuque (Stratum 5), dated approximately to 2.7 rcyr, where no other measurable skull could be found. As can be seen in Figure 10, its morphology is clearly within the East Asian/Amerindian dispersion and opposite in the morphospace to the morphology that characterizes the Colombian material in general.

DISCUSSION AND CONCLUSIONS

During the turn of the 19th century, comparative studies of human cranial morphology played a very impor-

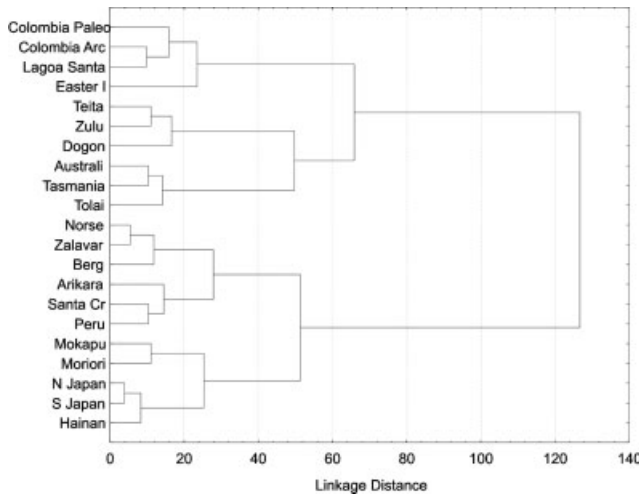


Fig. 9. Morphological affinities among the female series derived from Cluster Analysis (Ward's method) based on Mahalanobis Distances matrix.

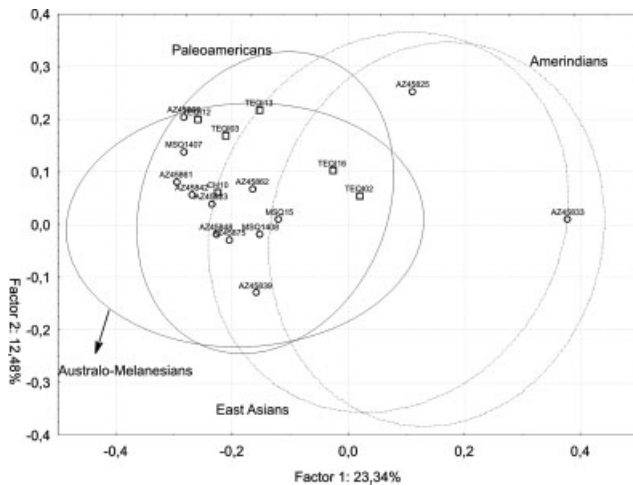


Fig. 10. Morphological affinities of the Colombian male individuals in relation to the morphological variability seen in Paleoamericans (Lagoa Santa), late Americans (Santa Cruz, Arikara and Peru), Australomelanesians (Australia, Tolai, and Tasmania) and Asians (North Japan, South Japan, and Hainan). The ellipses represent the 95% confidence dispersion of each region.

tant role in the discussion about the settlement of the Americas. The debate between Ales Hrdlička, Paul Rivet, and José Imbelloni during the first three decades of the 20th century is an example of this. While Rivet (1908) and Imbelloni (1938) suggested that the New World was occupied by more than one human biological population coming from the Old World, Hrdlička (1912) was unable to envisage such a scenario. For him, all cranial diversity of the Native Americans, past and present, could be accommodated in one single human biological stock. Much of this debate relied on a putative singularity of the cranial morphology of the early Americans (especially those from Lagoa Santa) when compared with later remains, especially recent and modern Amerindians.

For unknown objective reasons, Hrdlička's ideas prevailed in the literature until very recently. Even with

the rising of a population perspective in physical anthropology that permitted the discipline to move far beyond description, typology, and subjective judgment, no comparative reassessment of the cranial morphology of the early Americans was conducted during the 1960s, 1970s, and most of the 1980s. The complete absence of information derived from human skeletal remains in the literature about the settlement of the Americas during this period confirms this point. This is especially odd, if we consider that during the same time, comparative cranial morphology played a very important role among the North American anthropological community in understanding the colonization of other parts of the planet by humans.

Jantz and Owsley (2001) believe that this situation can be explained by two complementary causes. First, human skeletal remains of greater antiquity were, and still are, very rare in North America. Second, for the North American anthropological community, the problem had already been solved by Ales Hrdlička in the beginning of the 20th century. Since then the community assumed or took for granted that all Native Americans, from Paleoindians to actual Native Americans, could be seen as part of one same biological stock (called "Mongoloid" in the classic literature).

The absence of such investigations in South America during the same period is more complex to explain. In brief, classical and typological physical anthropology survived in South America until very late (see Mello e Alvim, 1977 for an example in the Lagoa Santa context). During the 1980s, when human skeletal remains finally began to be studied under a population perspective through the use of multivariate methods of quantitative analysis, the comparative morphological assessment of early South American human remains from a global perspective was almost immediately undertaken (see Neves and Pucciarelli, 1989 for the first contribution). Until recently, the shortage of funds to generate a reliable chronological framework for the potential Late Pleistocene/Early Holocene human remains, which sat in storage in many South American institutions, also delayed the triggering of these studies.

It is clear now that the cranial morphology of early South and Meso Americans (and possibly North America) was very different from that prevailing today among the native groups of these regions (see Neves and Hubbe, 2005, for a comprehensive study of South America and González-José et al., 2005 for Mesoamerica). While the predominant cranial morphology of modern and recent Native Americans tends to vary around a central tendency characterized by short and wide neurocrania, high and retracted faces, and high orbits and noses, the cranial pattern of the first South and Meso Americans tended to vary around a completely different morphology: long and narrow skulls, low and projected faces, and low orbits and noses (Neves and Hubbe, 2005). In South America the current predominant morphology appeared only after 8 reyr.

Two different scenarios can be envisaged to explain these important morphological changes: (a) The entrance of two very different biological populations in the New World during final Pleistocene/early Holocene times through Beringia,³ and (b) a local microevolutionary pro-

³This model, presented earlier as the "Two Main Biological Components Models," has been described in detail by Neves et al. (2003).

cess, mimicking the one that occurred in East Asia, at the same time. Although present information does not allow us to peremptorily dismiss any of these alternatives (Powell and Neves, 1999), the first hypothesis (dual entrance) is much more parsimonious in our view. It would be an astonishing coincidence that an evolutionary process happening in East Asia, was also happening concurrently yet independently in the Americas.

For instance, the differences in cranial shape implied are enormous, and not subtle. As shown by Howells (1973, 1989, 1995), as well as by our own analyses, cranial variation present today in the planet seems to cluster around two major patterns, one joining Sub-Saharan Africans and Australians, and another joining East Asians, Europeans, Polynesians (with the exception of Easter Island), and Amerindians. In accordance with Lahr (1996), the first pattern may be explained as a partial retention of the original cranial morphology of the first modern humans. Thus, when the first Americans are considered, the two most extreme morphologies present today in the planet were once represented in the New World. Accordingly, this scenario does not favor the possibility of genetic drift acting alone to generate the marked observed distinction. Although genetic drift has been recognized in the past few years as a potential important evolutionary factor in morphology (Ackerman and Cheverud, 2004; Marroig and Cheverud, 2004), we do not think that it alone could explain the presence of the morphological variation seen in the Americas when the first settlers are also taken into account.

The possibility of parallel evolution in Asia and in the Americas becomes still more unreliable if we consider that natural selection rarely affects human cranial morphological evolution. As well demonstrated and elaborated recently by Relethford (2002), Roseman (2004) and Roseman and Weaver (2004) genetic drift was the major potential evolutionary force acting in the differentiation of cranial shape after the appearance of our species in Africa. If these assertions are correct, the possibility of two independent processes leading to one same cranial pattern in the Old and in the New World would be remote, to say the least.

Important and independent support for the dual entrance model was recently generated by Dixon (2001), who proposed that the projectile points found in the earliest North American sites show that, in terms of weaponry, two different cultural traditions entered the New World in early times. An earlier tradition was characterized by the use of atlatl, and a later one, characterized by the use of bow and arrow.

Schurr (2004), after a comprehensive survey of the molecular literature, has also proposed a bipartite model of occupation for the Americas when mtDNA and YDNA polymorphisms are studied among modern Native Americans. However, for him, the second wave of settlers was restricted to North and Central Americas. On the other hand, most molecular biologists involved in the genetic study of present Amerindians recognize only one biological input to the New World (Bonatto and Salzano, 1997; Zegura et al., 2004).

Explaining the lack of congruence between morphological and molecular data is one of the main challenges for those who espouse that America was settled by two very distinct biological populations. Although cranial morphology as a whole seems to behave as a neutral evolutionary entity (Relethford, 1994, 2002; Roseman, 2004; Roseman and Weaver, 2004), this does not mean that

morphological and molecular data share one same evolutionary history. The lack of congruence should be expected, if we consider that molecular studies so far have not analyzed DNA portions that influence morphology. For example, this means that the coalescence time of molecular lineages probably does not coincide with the time of appearance of the morphology that typifies East Asian groups today. Most molecular studies carried out so far among living Native Americans have estimated times of entries varying from 12 to 35 rcyr. Few physical anthropologists today would risk affirming that by this time the cranial morphological pattern of present Asians and Native Americans (referred to as "mongoloid" in the classic literature) had already appeared in Northeastern Asia (Lahr, 1996).

The results obtained in this study support the idea that the first South Americans (represented here by Paleocolombians and Lagoa Santa) had a cranial morphology very different of that prevailing today in the Americas and in East Asia. They also support the idea that the peculiar cranial morphology of the first South Americans was not restricted to Lagoa Santa; on the contrary, it was generalized over most, if not all, the continent. This is easily deduced from the bidimensional graphs presented here. In the majority of these graphs, the two early South American samples are strongly associated with Australo-Melanesians. Sometimes, these early series are also associated with Easter Island. According to Howells (1973, 1989, 1995), Easter Islanders are the most "Australasian" looking people of Polynesia, and thus would also reveal a certain degree of retention of the generalized morphology of the first modern humans. Probably, this retention of certain generalized features in Easter Islanders is responsible for it showing an intermediate morphology between Australo-Melanesians and Polynesians, which would explain why it appears in some analyses associated with the former, while in others it shares biological affinities with the latter.

However, different from what was envisaged by one of us (WAN) and several collaborators in late 1980s and early 1990s, the Paleoamerican cranial morphology persisted at Sabana de Bogotá until very late (at least as late as the arrival of the Herrera ceramic tradition in the area). Rodriguez (2001) has suggested that this pattern of cranial shape could, in fact, have persisted in the region even until the arrival of the Spaniards in Colombia in the 16th century. Our findings support the idea of a long biological continuity at Sabana de Bogotá, covering at least 8,000 years (from 11 to 3 rcyr).

The stability of cranial morphology at Sabana de Bogotá over ~8,000 years deserves consideration. Although plant cultivation is as old as 5.0 kyr in the region, and the use of pottery recipients to process food is as old as 3.2 kyr, the cranial morphology of the local groups did not change as a response to these major shifts in their everyday life (contra Larsen, 1997). If Rodriguez (2001) is right, even the adoption of full-blown agriculture at Sabana de Bogotá was unable to cause any remarkable change in the local skull shape. Thus, no observable directional microevolutionary changes were happening during the time interval comprised here (11–3 kyr), and much less, a local microevolutionary process leading to short and wide neurocrania, high and flat faces, and high orbits and noses, which typifies most modern Native American groups. The later Colombian sample (Archaic Colombia) shows no sign of directional

change toward the Asian and/or the late Amerindian comparative series used in our investigation when compared with their predecessors (Paleocolombians).

Another point deserving further attention is the outlier nature of specimen AZ45833. As can be seen in Figure 10 this specimen is completely out of the 95% distributional ellipsis of both the Australasians and Paleoamericans, and well accommodated within the dispersion of the East Asians as well as Amerindians. As noted earlier, archaeologists operating at Sabana de Bogotá believe that the adoption of agriculture and pottery making around 3.2 kyr in the region was a result of intensive contact with adjacent *agroalfarero* groups, most probably those living west of the Sabana, at the Magdalena River Valley. We suggest (contra Rodriguez, 2001) that the presence of AZ45833 in the upper level of Aguazuque reflects these intensified contacts (probably with the Magdalena basin) and that the late Paleoamericans of Sabana de Bogotá lived side by side with human groups, exhibiting a completely different cranial morphology (the one prevailing today among Amerindians), but keeping with them a very restricted gene flow, at least until 3.0 kyr.

If this picture from Sabana de Bogotá and its surroundings can be extrapolated to other parts of South America where Paleoamericans lived since the end of the Pleistocene in high densities, it is not unreasonable to hypothesize that both phenotypes may have survived still differentiated until late times in the subcontinent, even in areas not as isolated as Baja California or Tierra del Fuego. In fact, in the bygone days of description and typology, some scholars seem to have grasped this scenario. To name a few, Lacerda and Peixoto (1876) suggested that the Botocudo Indians of Central-Eastern Brazil were direct descendants of the Lagoa Santa early population. Dixon (1923) suggested in his treatise that several remnants of his "Proto-Australoid" and "Proto-Negroid" types could still be found in marginal areas of both North and South America, while Neumann (1952) proposed a direct relationship between the Texas Coast tribes and the early inhabitants of the New World. Further efforts will be needed to check these and other possibilities of late survival of the Paleoamerican morphology, but now under a modern population approach.

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TABLE A1. Assumed chronology for the Colombian specimens

Males				Females			
Institutional ID	Site	Date (rcyr BP)	Series	Institutional ID	Site	Date (rcyr BP)	Series
CH10	Checua	7,800 ± 60 to 6,800 ± 40	Paleocolombia	SU45817	Sueva	10,090 ± 90	Paleocolombia
TEQ102	Tequendama	7,500 to 6,000	Paleocolombia	GACHASN	Guavio I	9,360 ± 45	Paleocolombia
TEQ103	Tequendama	7,500 to 6,000	Paleocolombia	CH07	Checua	7,800 ± 60 to 6,800 ± 40	Paleocolombia
TEQ112	Tequendama	7,235 ± 60	Paleocolombia	CH08	Checua	7,800 ± 60 to 6,800 ± 40	Paleocolombia
TEQ113	Tequendama	6,020 ± 45	Paleocolombia	CH13	Checua	8,200 to 7,200	Paleocolombia
TEQ116	Tequendama	7,500 to 6,000	Paleocolombia	TEQ101	Tequendama	7,500 to 6,000	Paleocolombia
MSQ1407	Vistahermosa	3,410 ± 35 to 3,135 ± 35	Archaic Colombia	TEQ102	Tequendama	7,500 to 6,000	Paleocolombia
MSQ1408	Vistahermosa	3,410 ± 35 to 3,135 ± 35	Archaic Colombia	TEQ103	Tequendama	7,500 to 6,000	Paleocolombia
MSQ15	Vistahermosa	3,410 ± 35 to 3,135 ± 35	Archaic Colombia	TEQ104	Tequendama	7,500 to 6,000	Paleocolombia
AZ45823	Aguazuque	4,030 ± 25	Archaic Colombia	TEQ107	Tequendama	7,500 to 6,000	Paleocolombia
AZ45825	Aguazuque	3,850 ± 35	Archaic Colombia	TEQ118	Tequendama	7,500 to 6,000	Paleocolombia
AZ45826	Aguazuque	4,030 ± 25	Archaic Colombia	MSQ1401	Vistahermosa	3,410 ± 35 to 3,135 ± 35	Archaic Colombia
AZ45828	Aguazuque	4,030 ± 25	Archaic Colombia	MSQ1402	Vistahermosa	3,410 ± 35 to 3,135 ± 35	Archaic Colombia
AZ45829	Aguazuque	3,850 ± 35	Archaic Colombia	MSQ1404	Vistahermosa	3,410 ± 35 to 3,135 ± 35	Archaic Colombia
AZ45830	Aguazuque	2,725 ± 35	Archaic Colombia	MSQ1405	Vistahermosa	3,410 ± 35 to 3,135 ± 35	Archaic Colombia
AZ45831	Aguazuque	2,725 ± 35	Archaic Colombia	MSQ1410	Vistahermosa	3,410 ± 35 to 3,135 ± 35	Archaic Colombia
AZ45832	Aguazuque	2,725 ± 35	Archaic Colombia	CHIA02	Chia III	5,040 ± 100	Archaic Colombia
AZ45833	Aguazuque	2,725 ± 35	Archaic Colombia	CHIA05	Chia III	5,040 ± 100	Archaic Colombia
AZ45835	Aguazuque	3,410 ± 35	Archaic Colombia	AZ45822	Aguazuque	4,030 ± 25	Archaic Colombia
AZ45837	Aguazuque	3,410 ± 35	Archaic Colombia	AZ45824	Aguazuque	3,850 ± 35	Archaic Colombia
AZ45839	Aguazuque	3,850 ± 35	Archaic Colombia	AZ45834	Aguazuque	3,410 ± 35	Archaic Colombia
AZ45842	Aguazuque	3,850 ± 35	Archaic Colombia	AZ45838	Aguazuque	3,410 ± 35	Archaic Colombia
AZ45848	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45840	Aguazuque	3,850 ± 35	Archaic Colombia
AZ45852	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45841	Aguazuque	3,850 ± 35	Archaic Colombia
AZ45857	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45843	Aguazuque	3,850 ± 35	Archaic Colombia
AZ45860	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45844	Aguazuque	3,850 ± 35	Archaic Colombia
AZ45861	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45845	Aguazuque	3,850 ± 35	Archaic Colombia
AZ45862	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45847	Aguazuque	4,030 ± 25	Archaic Colombia
AZ45864	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45849	Aguazuque	4,030 ± 25	Archaic Colombia
AZ45865	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45850	Aguazuque	4,030 ± 25	Archaic Colombia
AZ45866	Aguazuque	4,030 ± 25	Archaic Colombia	AZ45851	Aguazuque	4,030 ± 25	Archaic Colombia
AZ45875	Aguazuque	5,025 ± 40	Archaic Colombia	AZ45855	Aguazuque	4,030 ± 25	Archaic Colombia
AZ45879	Aguazuque	3,850 ± 35	Archaic Colombia	AZ45856	Aguazuque	4,030 ± 25	Archaic Colombia
				AZ45859	Aguazuque	4,030 ± 25	Archaic Colombia
				AZ45863	Aguazuque	4,030 ± 25	Archaic Colombia
				AZ45867	Aguazuque	4,030 ± 25	Archaic Colombia
				AZ45868	Aguazuque	4,030 ± 25	Archaic Colombia
				AZ45869	Aguazuque	4,030 ± 25	Archaic Colombia
				AZ45872	Aguazuque	5,025 ± 40	Archaic Colombia
				AZ45873	Aguazuque	5,025 ± 40	Archaic Colombia
				AZ45874	Aguazuque	5,025 ± 40	Archaic Colombia

TABLE A2. Individual measurements of Colombian male specimens (in millimeters)

	CH	TEQ	TEQ	TEQ	TEQ	TEQ	TEQ	MSQ	MSQ	MSQ	MSQ	AZ	AZ	AZ	AZ	AZ	AZ	AZ	
	10	102	103	112	113	116	116	1407	1408	15	45823	45826	45828	45829	45830	45831	45832	45833	
Glabello-occipital length (GOL)	187	174	192	192	194	180	180	190	184	183	190	182	195	177	-	-	-	-	179
Nasio-occipital length (NOL)	186	173	186	187	188	179	188	185	181	180	187	175	-	176	-	-	-	-	176
Maximum cranial breadth (XCB)	122	129	130	126	134	136	136	131	134	129	130	-	128	133	-	-	132	145	
Maximum frontal breadth (XFB)	107	103	109	106	108	112	112	110	112	108	109	110	110	112	-	-	109	129	
Biauricular breadth (AUB)	119	115	122	124	125	127	127	118	121	119	123	-	-	-	-	-	-	139	
Biasterionic breadth (ASB)	113	104	107	106	114	111	111	105	108	109	107	-	-	-	-	-	104	107	
Nasion-prosthion height (NPH)	72	74	67	68	69	63	63	70	68	73	77	-	-	-	71	65	-	69	
Nasal height (NLH)	52.5	51	48	50	51	48.5	51	50	53	53.5	52	-	-	-	54	45	-	50.5	
Orbit height (OBH)	33	31	33	31	36	33.5	33.5	35	38	33	32.5	-	30	-	33	33	-	32	
Orbit breadth (ORB)	42	36.5	37	42	38	36.5	36.5	38	36	37	36.5	-	-	-	37	35	-	37	
Bijugal breadth (JUB)	119	107	115	116	120	116	116	114	115	117	113	-	-	-	-	112	113	123	
Nasal breadth (NLB)	28	22.5	25	27	23	26	26	25	27	26	27	-	-	-	24	25	27	26	
Bimaxillary breadth (ZMB)	-	95	95	106	104	98	98	96	105	105	97	-	-	-	94	102	100	106	
Bifrontal breadth (FMB)	100	92	95	100	101	100	100	97	100	97	100	100	96	-	99	100	96	104	
Nasio-frontal subtense (NAS)	15	13	14	15	12	14	14	15	17	13	15	15	-	-	15	16	-	15	
Interorbital breadth (DKB)	25	18.5	25	21	22	23.5	23.5	23	25	22	24	23.5	-	25	23	26	-	27	
Malar length, inferior (IML)	-	34	38	34	40	37	39	39	36	37	36	-	35	-	-	40	-	40	
Malar length, maximum (XML)	-	52	55	53	60	54	54	51	50	56	57	-	50	-	-	55	-	64	
Malar subtense (MLS)	-	11	10	10	12	9	9	12	8	13	11	-	7	-	-	10	-	11	
Cheek height (WMH)	27	23	27	23	27	26	26	22	25	24	24	-	22	-	25	24	22	24	
Frontal cord (FRC)	108	109.5	112	112	114	106	106	117	113	108	107.5	107	-	108	118	-	-	105	
Frontal subtense (FRS)	21	21	25	25	27	19	19	27	23	25	24	25	-	21	26	-	-	18	
Nasion-subtense fraction (FRF)	43	51	51	45	52	45	45	52	49	47	51	40	-	45	52	-	-	58	
Parietal cord (PAC)	110	102	119	118	123	122.5	122.5	126	122	116	119	127	-	110	-	-	122	103	
Parietal subtense (PAS)	22	20	27	23	26	26	26	27	28	23	27	31	-	26	-	-	25	19	
Bregma-subtense fraction (PAF)	62	58	54	65	63	60	60	67	62	57	69	70	-	55	-	-	63	57	
Occipital cord (OCC)	-	91	98	102	107	98.5	98.5	99	96	-	98	-	-	96	-	-	-	113	
Occipital subtense (OCS)	-	26	33	33	38	29	29	31	28	-	32	-	-	28	-	-	-	29	
Lambda-subtense fraction (OCF)	-	41	49	51	61	55	55	53	44	-	44	-	-	53	-	-	-	63	
Nasion radius (NAR)	100	91	96	102	96	91	91	97	100	96	98	-	-	-	-	-	-	104	
Frontalmalare radius (FMR)	88	78	83	88	84	79	79	84	83	83	84	-	-	-	-	-	-	87	

(continued)

TABLE A2. (Continued)

AZ45 835	AZ45 837	AZ45 839	AZ45 842	AZ45 848	AZ45 852	AZ45 857	AZ45 860	AZ45 861	AZ45 862	AZ45 864	AZ45 865	AZ45 866	AZ45 875	AZ45 879	AZ45 825
185	-	177	183	184	-	184	-	191	196	196	185	196	-	193	186
-	-	174	181	181	-	-	-	186	191	193	180	191	-	187	181
138	132	129	127	131	-	128	-	125	146	127	137	129	-	-	142
-	114	112	103.5	114	-	103	-	104	-	103	-	111	104	-	114
-	-	118	115	118	-	-	-	121	-	-	-	123	116	-	-
-	-	103	103	107	-	99	-	100	-	-	-	116	-	-	-
-	-	67	71	71	-	-	69	72	78	-	77	75	74	67	74
-	-	54	52	51.5	-	-	50	56	52.5	-	56.5	53	53	50	51
-	-	32.5	32.5	34.5	29.5	-	35	35	35	-	36.5	35	37	33	33
-	-	39	37.5	36	35	-	37	39	37.5	-	-	41	37	37	37
-	-	119	111	115	-	-	115	118	110	-	-	118	-	-	113
-	-	26.5	27.5	26	-	-	23	26	25	-	-	24.5	26	-	23.5
-	-	97	104	98	-	-	95	104	96	-	-	94	103	-	91
97	-	100	97	99	-	90	97	102	95	95	107	100	98	-	97
9	-	15	15	11	-	-	15	12	11	13	-	13	17	-	14
25	-	22.5	22	25	-	-	-	23.5	24	-	23	24	22	-	23
-	-	43	30	40	36	-	38	35	-	-	-	39	-	44	37
-	-	55	51	59	52	-	53	51	-	-	-	53	-	58	52
-	-	12	10	12	9	-	10	12	-	-	-	9	-	10	11
-	-	22	25	24	25	-	20	22	24	-	-	23	25	24	22
-	-	109.5	113	111	-	-	110	112.5	115	121	123	116.5	110	115	112
-	-	29	27	24	-	-	27	25	28	30	29	26	-	27	27
-	-	52	45	44	-	-	48	57	54	48	52	48	-	53	46
-	-	118	120	121.5	-	117	-	122	135	114	-	128	-	128	109.5
-	-	26	27	28	-	24	-	30	34	20	-	29	-	29	23
-	-	54	61	69	-	62	-	60	67	66	-	64	-	59	60
95	-	-	92	94.5	-	-	-	101.5	95	-	-	102	-	-	105
35	-	-	30	29	-	-	-	32	34	-	-	35	-	-	37
44	-	-	50	50	-	-	-	49	39	-	-	47	-	-	57
-	-	98	100	100	-	-	-	100	-	-	-	97	102	-	-
-	-	85	87	84	-	-	-	86	-	-	-	84	88	-	-

APPENDIX B: DESCRIPTION OF THE SITES FROM WHERE THE COLOMBIAN MATERIAL WAS EXHUMED

Sueva 1 is a sandstone rock-shelter located at the right margin of the Juiquín River, at 2,690 m above sea level (4°48' latitude north; 73°43' longitude west). Excavations at Sueva 1 were carried out mainly in 1978, under the supervision of one of us (GC). A comprehensive description of the site and its content can be found in Correal (1979), the main source of the synthesis that follows. The region where the site is located was occupied by humans since the end of the Pleistocene until the late Holocene.

Six well-defined stratigraphic levels were identified in the site. They were numbered bottom to top. Stratum 1 showed no signs of human activity. Stratum 2 recorded the first evidence of human activities. The low density of cultural and faunal remains in this level suggested that few human groups were present in the surrounding landscape by the end of the Pleistocene. No dates are available for Stratum 2. However, the base of the overlying Stratum 3 was dated by C-14 to 10,090 ± 90 rcyr (Sample GrN 8111). This stratum was very rich in archaeological remains, including expressive numbers of stone artifacts and flaking debris (most of them related to the Abriense repertoire), and faunal remains. Concave scrapers were by far the most popular stone tool manufactured and used during this time. Foreign raw-materials were extensively used during the first intensive occupation of Sueva, which indicates high mobility and/or long distance trade. Hunting concentrated on medium and small mammals, mainly white-tailed deer (*Odocoileus virginianus*) and rodents. Gastropods (*Drymaeus gratus*) were also collected as food supplement. A profusion of lithic debris in this level indicated that knapping was frequently performed in the site in the very beginning of the Holocene.

The only human burial found in the site was associated with Stratum 3. A highly flexed female skeleton was buried in left-lateral fetal position, with several stone artifacts, red ocher, and faunal remains deposited as mortuary offerings.

Stratum 4, restricted only to the western part of the shelter, was completely devoid of cultural remains. This stratum was estimated to be dated to between 9.0 and 7.0 rkyr. Stratum 5 began to be deposited around 7.0 rkyr. A conventional C-14 date of 6,350 ± 40 AP rcyr (sample GrN 8111) was obtained for the lower part of this stratum. Less cultural remains were found at Stratum 5 when compared with Stratum 3. Concave scrapers, which were the most popular artifact in the site by the beginning of the Holocene, were replaced mainly by terminal scrapers. Laminar knives also became very popular during this period. Deer hunting was the main animal food source, and rodents became completely absent from the dietary repertoire during this time.

A well-defined living-space floor was detected in Stratum 5. Stratum 6, which is estimated to span the last 2,000 years, corresponds to an occupation of the rock shelter by ceramist groups relying on cultivated plants as their staple. Again, deer hunting was the main source of animal protein.

In general, the stone industry, the subsistence strategy, and the settlement pattern revealed at Sueva 1 is very similar to what was found in other early sites of Sabana de Bogotá, as El Abra (12,460 ± 160 GRN 5556),

TABLE A3. (Continued)

	AZ45 834	AZ45 838	AZ 45840	AZ45 841	AZ45 843	AZ45 844	AZ45 845	AZ45 847	AZ45 849	AZ45 850	AZ45 851	AZ45 855	AZ45 856	AZ45 859	AZ45 863	AZ45 867	AZ45 868	AZ45 869	AZ45 872	AZ45 873	AZ45 874
Frontal subdense (FRS)	48	53	46	44	50	42	45	47	44	42	46	50	-	46	41	45	51	44	40	41	41
Nasion-subdense fraction (FRF)	-	116	121	109	123	119	106	115	123	-	115	101	122	125	102	-	124	124	115	-	115
Parietal cord (PAC)	-	21	26	23	25	25	18	25	28	-	26	18	27	28	21	-	24	30	23	-	26
Parietal subdense (PAS)	-	67	67	60	66	58	50	60	75	-	65	58	34	64	50	-	68	59	53	-	65
Bregma-subdense fraction (PAF)	-	-	95	97	98	97	110	96	97	-	100	102	104	95	94	-	97	92	98	-	97
Occipital cord (OCC)	-	-	27	30	28	27	32	30	29	-	34	33	28	33	31	-	28	27	29	-	30
Occipital subdense (OCS)	-	-	47	45	45	47	55	40	50	-	45	53	43	42	45	-	55	41	38	-	42
Lambda-subdense fraction (OCF)	-	-	98	91	-	89	92	95	96	99	105	93	-	99	88	-	105	93	92	-	86
Nasion radius (NAR)	-	-	83	77	-	77	83	81	85	87	87	83	-	87	74	-	86	78	79	-	73
Frontalmalare radius (FMR)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Tequendama 1, and Nemocón 4 (>8.0 kyr). The human face found in Stratum 3 of Sueva 1 is apparently also very similar to other human specimens found in contemporary sites in the region.

Guavio 1 is a limestone rock-shelter located at 4°41' of latitude north and 73°30' of longitude west, in the municipality of Gachalá, at 1758 m above sea level. So far the site has been referred to in the local literature as Gachalá, yet it has not been reported at length in the literature. The site was excavated under the coordination of one of us (GC) in 1975. A total area of 40 m² was excavated. The deepest archaeological material was found at a depth of 1.30 m. Four well-defined cultural strata were revealed by the excavations, overlying a sterile stratum of yellow clay. They were numbered bottom to top.

Stratum 1 was composed primarily of a yellow-clayish sediment (1.10–1.30 m); Stratum 2 was composed of a brown-clayish sediment (1.00–1.10 m); Stratum 3 was composed of a very coarse brownish sediment (0.40–1.10 m); while Stratum 4 was composed of a loose brownish sediment rich in fallen fragments of limestone. Chert was the preferred raw material for flaking. The lithic industry was very similar to those of El Abra and Tequendama: abundant flaking debris, several kinds of unretouched used flakes, cores, blade knives, and four different classes of scrapers, of which the lateral scrapers were the predominant tool.

The few bone instruments found in the site were associated with Stratum 4, namely a diaphyseal fragment with a circular perforation, a needle, and a borer made of a deer long-bone. Several mineral fragments, such as quartz and hematite, were found in Strata 2, 3, and 4. Remnants of baked clay-lined fire pits were found in the same units as well.

Faunal remains were not found in the first cultural level. However, the remaining strata were rich in bones of armadillo (*Dasypus novemcinctus*), agouti (*Dasyprocta* sp.), white-tailed deer (*Odocoileus virginianus*), coati (*Nasua nasua*), paca (*Agouti paca*), rat (*Sigmodon bogotensis*), long-tailed weasel (*Mustella frenata*), black-eared opossum (*Didelphys marsupialis*), howler monkey (*Alouatta seniculus*), and gray fox (*Vulpes cinereoargenteus*). Bird bones were rare. Gastropods were used as food supplement in all the strata.

Eight human burials were exhumed in Guavio 1 (five adults, and three subadults), in highly flexed lateral position. Most of the bones were poorly preserved due to the acidity of the sediments. In Burial 8, an adult female, associated with Stratum 3, was the only one that permitted morphological assessments. Stone artifacts, unretouched flakes, hematite plaques, animal bones, and gastropod shells were deposited in the burial pits. Stone artifacts were completely absent in the case of the subadults. Scattered isolated burnt human bones were found in Strata 3 and 4, as well. A charcoal sample directly associated with Burial 8 was dated to 9,360 ± 45 rcyr (Sample GrN 8.448). This is so far the only chronological information generated for Guavio 1.

Tequendama 1 and 2 is a complex of small sandstone rock-shelters located at the right margin of the Quebrada el Rodeo, affluent of Bogotá River, at 2,570 m above sea level (~4°35' latitude north; 74°13' longitude west). Excavations at the site in 1970 were carried out in two different areas (separated by ~7.0 meters), under the coordination of one of us (GC). The two areas were designated as Tequendama 1 and 2. A detailed monograph about the site can be found in Correal and van

der Hamenn (1977), the main source of the synthesis presented here.

The synthesis will be based mainly on the characteristics of Tequendama 1, since excavations at Tequendama 2 were very restricted in area and depth. The human occupation in the site was dated to between 10,920 ± 260 rcyr (GrN 6539) and 2,225 ± 35 rcyr (GrN 6536). Nine different natural stratigraphical levels were defined in the site. The first 4 levels and the base of Stratum 5(a) were completely devoid of traces of human activity. They are dated approximately to between 30.0 and 12.0 rcyr.

The first signs of human activities, although meager, were found in the upper sequence of Level 5(a). These human debris are certainly slightly older than 10,920 ± 260 rcyr, the date obtained for the transition between 5a/5b. Stratum 5b exhibited the first traces of a dense human occupation at Tequendama. Level 5b was dated to between 10,730 ± 105 (GrN 6270) and 10,130 ± 150 (GrN 6732) rcyr. Hearths, artifacts, and animal bones were plenty in this level.

When humans began inhabiting the rock-shelter (top of level 5a), Stratum 6 was basically formed by a mixture of loess and volcanic ashes, and was dated to between 10,025 ± 95 (GrN 6210) and 9,740 ± 135 (GrN 7115) rcyr. Since the date of 9.7 rcyr was obtained in the middle of this stratum, its upper limit was estimated to be dated to around 9.5 rcyr. A very low density of human debris was found in Stratum 6.

No radiocarbon date was obtained for the subsequent Level 7 (also subdivided in a and b). However, its span of time was estimated to be between 9.5 rcyr and 7.0 rcyr. Stratum 7a was almost absent in the interior of the rock-shelter and was mostly characterized by a high content of mammal bones and artifacts. The faunal remains formed a bone strip in the base of the stratum. A similar feature was dated to 8,760 ± 350 rcyr (sample B-2137) at El Abra, also an important early site excavated at Sabana (Hurt et al., 1976). The sedimentary matrix was formed primarily by grey sand and humus. As in El Abra, remnants of baked clay-lined fire pits were found during the same period (circa 9.0 rcyr).

Stratum 7b was very similar in terms of sedimentation to Stratum 7a. However, Stratum 7b was also represented in the interior of the rock-shelter. Although present, animal bones and artifacts were less numerous than in 7a. Stratum 8 (subdivided in a and b, as well) also contained artifacts and animal bones. While Stratum 8a was dated to between 7,090 ± 75 (GrN 6729) and 6,395 ± 70 (GrN 6537) rcyr, Stratum 8b was estimated to be between 6.0 and 2.5 rcyr. Stratum 9 was characterized by a dark sediment rich in organic material and the presence of ceramic fragments. The only date obtained for this level was 2,225 ± 35 rcyr (GrN 6536), with the charcoal sample coming from the middle of the stratum.

The transition from Stratum 8b to 9 suggests that the regional population was small, if any, when compared with earlier and later periods. The beginning of Stratum 9 was estimated to be dated to circa 2.5 rcyr. Among the 14 mammal species identified as food source in Tequendama, white-tailed deer (*Odocoileus* sp.) and brocket deer (*Mazama* sp.) predominated in the early horizons, while wild guinea pig (*Cavia porcellatus*) became the predominant species in later times. These figures emerged when the minimum number of individuals was considered. However, when the contribution of both species was assessed in terms of amount of meat

(weight) returned, deer emerged as the main hunted species during all phases of occupation (its importance varied in fact from 98% to 78%, bottom to top).

Domesticated guinea pig also became an important source of animal protein for the agriculturalists who appeared in the region around 2.5 rkyr. Interestingly enough, a continuous size increment was observed in wild guinea pig from bottom to top, suggesting a long process of domestication. The consumption of gastropods also increased from bottom to top, with no remains found in the Pleistocene level.

Direct percussion characterized most of the lithic industry. Only three bifacial instruments were retouched by pressure. The lithic industry was finer in the beginning of the occupation of the rock-shelter than in later periods. All bifacial tools produced by pressure, including a fragment of a projectile point, were found in the base of the sequence. The bone industry was meager in the beginning of the occupation and apparently became very important in the middle of the sequence.

A total of 21 burials were found at Tequendama 1, most of them concentrated at levels 8 and 7. Burial 14 is believed to be the oldest one, dated to between 9.0 and 8.0 rkyr. The remainder is estimated to be bracketed between 6.0 and 7.2 kyr (as well as the five burials found at Tequendama 2). The skeletons of burials 7, 12, and 13 were directly dated by conventional C-14 and generated the following dates, respectively: $5,805 \pm 50$ (GrN 7476), $7,235 \pm 60$ (GrN 7477), and $6,020 \pm 45$ (GrN 7478) rkyr. All corpses were deposited in lateral or dorsal flexed position, with the exception of Burial 14, the oldest one, which was heavily cremated. In the case of adults the burial pit was oval, while in the case of infants, circular. Artifacts of bone and horn were frequently deposited in the graves, as mortuary associations.

Checua is an open air site associated to the basin of Checua River. The site is located on top of a low hill, at 2,600 m above sea level ($\sim 5^{\circ}04'$ north latitude; $73^{\circ}53'$ west longitude). Checua was excavated in 1991 under the coordination of Ana María Groot. Groot (1992, 1995) was the main source for the synthesis that follows. The time covered by Checua spans from 8.5 to 3.0 rkyr. Eight stratigraphical levels were clearly identified in the site (numbered bottom to top).

Strata 1, 2, and 3 were completely devoid of human debris and were composed primarily by volcanic ashes and aeolic deposited whitish sand. Stratum 4 marks the initial human occupation (Occupation 1) of the site and reveals occasional short episodes of permanence. Few stone artifacts were identified in this level (cutting flakes and blades, and scrapers). Stone tools related to the processing of seeds and tubers (mortars) were also found in Stratum 4. A conventional C-14 date of $8,200 \pm 110$ rkyr (Lab information not provided by Groot 1992) was obtained from a charcoal sample collected in the transition between Stratum 4 and overlying Stratum 5 (Occupation 2).

A charcoal sample collected approximately at the middle of Stratum 5 was dated to $7,800 \pm 160$ rkyr (Beta 53924). As a whole, Stratum 5 (a, and b) showed a much denser occupation when compared to the previous level. The apex of this occupation corresponded to the upper part of this unit, identified as 5b. A very compact living floor, where charcoal sample for dating was collected from, was evidenced in Stratum 5b. Postholes delimited a hut of 7.5 m of diameter in this floor.

Nine human burials were found associated with Stratum 5b. Although no absolute date is available for the

top of Stratum 5, the principal excavator was able to establish a parallel between this level and Stratum 5 of Nemocón 4, another local site, dated to between $7,530 \pm 100$ rkyr (GrN 8281) and $6,825 \pm 40$ rkyr (GrN 8456) (Correal, 1979). The cultural material associated with this occupation was formed primarily by cutting tools (on flakes and blades), mortars to process plant items, red ocher (used in the funerary treatment), and a rich variety of bone artifacts, including a flute.

White-tailed deer (*Odocoileus virginianus*) and guinea pig (*Cavia porcellus*) were the most hunted species during the occupation of Stratum 5. Stratum 6 was completely sterile. Stratum 7 corresponded to another dense occupation of the site, with the formation of another compact living floor. At least one hut with a diameter of 3.5 m was built during this occupation. Bone artifacts were found in this level in high numbers, including lanceolate scrapers, borers, and drills. Lithic tools were restricted to cutting flakes and blades, although flaking debris and cores were well represented. White-tailed deer now surpassed guinea pig as preferred game.

Stratum 8 is marked, in its bottom (8a), by the presence of four human burials (one adult, and three subadults). Several isolated human bones were also found scattered in this stratum. As a whole, bone artifacts are less represented in this level, when compared to the previous one. Deer became the most preferred game. Flaking debris were well represented, associated with a stone industry formed by cutting blades and flakes, and scrapers. The presence of pot shards and mortars in this level attest to the importance of plant cultivation during this period. No absolute date is available for Stratum 8, but compared to other neighboring sites, its age is estimated to be around 3.0 rkyr.

Aguazuque is an open air preceramic site on top of a fluvial terrace, located at Vereda Canoas, Soacha county, approximately at $4^{\circ}37'$ of latitude north, and $74^{\circ}17'$ of longitude west, 2,610 m above sea level. The site was excavated in 1985 under the direction of one of us (GC). A detailed monograph about the site can be found in Correal (1989), from which the following synthesis was elaborated.

Two areas of excavation were established in Aguazuque, one of 12 m² (Area 1), and another of 64 m² (Area 2). Only 2 m separated both areas. The maximum depth of the archaeological package, namely 2 m, was registered in Area 1. Seven stratigraphical levels were defined in Aguazuque (numbered bottom to top).

The first human traces found in the site were dated to $5,025 \pm 40$ rkyr (GrN 14.477), while the latest provided an age of $2,725 \pm 35$ rkyr (GrN 14.479). The lithic industry recovered in the site could be classified as Abriense (simple unifacial instruments with just one edge retouched by direct percussion). Scrapers were by far the most popular formal instrument found, and knapping debris abounded as well. Several polished stone tools were also found, suggesting an important participation of plant items in the local diet.

Contrasting the lithic industry, highly elaborated bone artifacts were found. In fact Aguazuque is still considered the site with the most elaborated bone industry ever found during the preceramic period of Sabana de Bogotá. Seventeen different mammal species were identified among the food debris. Among them, deer of two distinct genus (*Odocoileus virginianus* and *Mazama* sp.) were the main source of animal protein. Reptiles, birds, and fish remains, and occasionally invertebrates, were

also identified among the faunal assemblage recovered from Aguazuque.

Fifty-nine human burials were uncovered from the site, 51 in Area 1, and 8 in Area 2. Burial activities were undertaken during most of the occupation of the site, with the exception of the superficial ceramic stratum. The burial practices included single primary burials, double primary burials, collective primary burials, and several kinds of secondary ritual interments. Adults were buried on their right, left or dorsal sides, highly flexed. Faunal bones, lithic and bone instruments were the most important elements used as funerary associations.

Aguazuque is still the only preceramic site of Sabana de Bogotá, where several individuals (23) were deposited in one large pit, forming a circle with 4.5 m of diameter (Stratum 4). Correal (1989) suggested this area was a ritual place, where cannibalism was practiced, since a series of isolated human and animal bones were found scattered within the circular structure. The structure could also be the result of burying the dead along the walls of a circular hut. Two highly decorated calvaria were found associated with one secondary ritual interment. Animals, like turtles, parrots, and small mammals were also formally buried in Aguazuque.

Several other structures were found in the site, most of them at Stratum 3, as couvette hearths, living floors and circular structures delimited by postholes; these last suggesting the huts were circular, and having diameters between 2 and 4 m. For Correal (1989) these circular huts were established as hives, as in other parts of Colombia. Several plant remains used as food items were also found at Aguazuque. A date of $3,850 \pm 35$ rcyr was obtained from a carbonized seed of squash (*Cucurbita pepo*). This date is still today the oldest direct indicator of plant cultivation for Sabana de Bogotá.

Chia 3 is a rock-shelter located at $\sim 4^{\circ}53'$ of latitude north and $74^{\circ}03'$ of longitude west, at 2,610 m over the sea level, in Chia county, north of Bogotá, associated with the basin of Quebrada Yerbabuena. The site was excavated under the direction of Gerardo Ardila in 1980. Detailed description and interpretation of the archaeological material found in this site and other 10 surrounding sites can be found in Ardila (1984), the main source of the synthesis that follows.

The stratigraphy of the site was similar to others in the region. Four distinct strata were defined in this rock-shelter (numbered bottom to top). The base of the sequence (Stratum 1) was formed by a yellow clay sedimentary layer ~ 2 m thick. Stratum 2 corresponded to a very thin layer of sand, while Stratum 3 corresponded to a gray-yellowish sand, almost 1 m thick. These layers were topped by Stratum 4, being very thin (maximum 0.25 m), corresponding to a gray sand strongly affected by erosion. Only 20 m² were excavated. No ceramic shard was found in the top of the sequence, probably due to the intensive erosion of Stratum 4.

A date of $2,090 \pm 60$ rcyr (Sample GrN 10267) obtained in Chia II can be used as the landmark for the establishment of the Herrera Tradition in the Chia region as a whole. According to Ardila (1984), the appearance of pottery making in the Chia region around 2.0 rcyr was abrupt, suggesting the arrival of a new human population and culture in the area. He also suggested that the newcomers brought with them a tropical forest cultural tradition, via the Magdalena River valley.

Seven burials were uncovered at Chia III. However, only two skulls were capable of being reconstructed. A conventional radiocarbon date of $5,040 \pm 100$ rcyr (sample GrN12122) was obtained from a fragment of the human skeleton from burial 5. In accordance with Ardilla (1984), the site was occupied by one same small group of hunter-gatherers. Dental cavities diagnosed in several human skeletons from Chia III demonstrated that, although hunter-gatherers, the group that occupied the site made a vast use of plant items rich in carbohydrates. This is the earliest case of dental cavities reported for the preceramic period of Sabana de Bogotá. Chert was the favorite knapping raw material. Only small Abriense tools were found. Concave scrapers predominated in the local tool kit. Again, deer was the most important source of animal protein.

Vistahermosa is located in Mosquera county, in the area owned by Hacienda Vistahermosa, Sabana de Bogotá. The site is located in a terrace associated with the basin of the lake La Herrera located at $4^{\circ}41'$ of latitude north and $74^{\circ}15'$ of longitude west and 2,590 m above sea level. The Vistahermosa region is famous in the Colombian scientific literature because of the important megafauna fossil bones found there since the beginning of the 20th century and dated to the late Pleistocene (10.0–22.0 rkyr). The site was excavated in 1985 by one of us (GC). The only published information about the excavations of Vistahermosa can be found in a short note published by Correal (1987), the main source used to elaborate this synthesis.

An area of 64 m² was systematically excavated. Two cultural levels were detected, numbered top to bottom. Stratum 2 refers to the earliest archaeological findings in the site. Few faunal and lithic remains were collected in this level. Stratum 1, more superficial exhibited a floor of blocks, 0.20-m thick. Apparently this habitation floor corresponded to a hut. Stratum 1 was much richer than Stratum 2 in terms of archaeological material. A diversified lithic and bone industry was found in it. Scrapers and blade knives were the most represented artifacts among the stone tools. Several hearths and five human burials were found in Stratum 1. In one of them five isolated human skulls were deposited in the grave as mortuary associations. White-tailed deer, guinea pig, fox, and birds were the main source of animal protein. The presence of locally nonoccurring rocks in the site suggested frequent contacts with the adjacent Magdalena River Valley. Stratum 1 was dated to $3,135 \pm 35$ rcyr, while Stratum 2, to $3,410 \pm 35$ rcyr.