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Brief Communication: "Zuzu" Strikes Again—Morphological Affinities of the Early Holocene Human Skeleton From Toca dos Coqueiros, Piaui, Brazil

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ABSTRACT The Serra da Capivara National Park in northeastern Brazil is one of the richest archaeological regions in South America. Nonetheless, so far only two paleoindian skeletons have been exhumed from the local rockshelters. The oldest one (9870 ± 50 BP; CAL 11060 ± 50), uncovered in Toca dos Coqueiros and known as "Zuzu," represents a rare opportunity to explore the biological relationships of paleoindian groups living in northeastern Brazil. As previously demonstrated, South and Central America Paleoindians present skull morphology distinct from the one found nowadays in Amerindians and similar to Australo-Melanesians. Here we test the hypothesis that Zuzu shows higher morphological affinity with Paleoindians. However, Zuzu is a controversial skeleton since previous osteological assessments have disagreed on several aspects, especially regarding its sex. Thus, we compared Zuzu to males and females independently. Morphological affinities were assessed through clustering of principal components considering 18 worldwide populations and through principal components analysis of the individual dispersion of five key regions for America's settlement. The results obtained do not allow us to refute the hypothesis, expanding the known geographical dispersion of the Paleoindian morphology into northeast Brazil. To contribute to the discussion regarding Zuzu's sex, a new estimation is presented based on visual inspection of cranial and postcranial markers, complemented by a discriminant analysis of its morphology in relation to the paleoindian sample. The results favor a male classification and are consistent with the mortuary offerings found in the burial, yet do not agree with a molecular determination. Am J Phys Anthropol 134:285–291, 2007. ©2007 Wiley-Liss, Inc.

The study of ancient South and Central America skulls over the last 20 years shows that the earliest groups arriving in the New World had a distinct morphological pattern to that characterizing Amerindians today. This typical morphological pattern has been known as paleoamerican and shares strong morphological affinities with Australo-Melanesian groups (long and narrow skulls, low and projecting faces, and low orbits and noses; Neves and Hubbe, 2005). Recent Amerindians, on the other hand, present morphology similar to East Asians, classically known as mongoloid (short and wide neurocrania, high and retracted faces, and high orbits and noses). This evidence allowed, in the late 1980s, for the proposition that America was settled by two distinct biological human components.[1] Accordingly, Paleoindians represent the first groups to enter the New World and were mostly substituted during the Holocene by groups with mongoloid morphology [see (Gonzalez-José et al., 2003; Neves et al., in press) for evidence of late survival of paleoamerican morphology into the Holocene].

So far, in South and Central America all cranial collections and isolated specimens analyzed and older than 7.5 kyr corroborate the dual-entrance model, i.e. they show higher morphological affinity with Australo-Melanesians than with East Asians or Amerindians. This morphological pattern has been found in Lagoa Santa, Central Brazil (Neves and Hubbe, 2005), where 81 skulls from the same population were analyzed; in the Bogotá Savannah, Colombia (Neves et al., in press), a sample composed of 17 skulls; in Central México (González-José et al., 2003), represented by 5 skulls; and in isolated skulls in Southeastern Brazil (Capelinha; Neves et al., 2005), Central Brazil (Toca das Onças; Hubbe et al., 2004), and in Southern Chile (Palli Aike; Neves et al., 1999). Thus, in the last years the study of the oldest human remains from the New World has shown that the

[1]This model was named the "Two Main Biological Components Model," and a detailed description of it can be found in Neves et al., 2003.

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morphology that characterizes these groups was widespread in these subcontinents.

In northeastern Brazil, however, the morphological affinities of old human remains have not been studied, despite the fact that one of the richest archaeological areas of South America is located in this region: the Serra da Capivara National Park, with more than 500 known sites. Nevertheless, the whole area has yielded thus far only two early human skeletons. The oldest one was exhumed from the Toca dos Coqueiros, in one of the many local rock-shelters, and is dated to 9870 ± 50 BP (11060 ± 50 CAL BP; Beta 109844). The second was found at Toca da Janela da Barra do Antonião (9,670 ± 140 BP; 10583–11385 CAL BP; GIF-8672), another rock-shelter. The two skeletons are fairly well preserved, only the burial from Toca dos Coqueiros has its skull preserved. Thus, although an isolated specimen, it represents a rare opportunity to investigate the morphological affinities of early humans who settled the Brazilian Northeast.

Discovered in 1997, the single burial of Toca dos Coqueiros is known as "Zuzu" and is one the earliest human skeletons from South America. Zuzu has been a highly controversial topic in this journal because of the contradictory results obtained by different physical anthropologists regarding the determination of its sex. Lessa and Guidon (2002) presented a comprehensive descriptive assessment of the skeleton, characterizing it as a middle-adult female. They also described a set of paleopathological markers in the skeleton and an interproximal dental groove interpreted as caused by the use of tooth pick. In contrast, Nelson (2005), who had the opportunity to reconstruct Zuzu's remains, reported several interpretations contradicting those of Lessa and Guidon (2002). Among other distinctions, he characterized the individual from Toca dos Coqueiros as a gracile male. The classification of Zuzu as a gracile male is indirectly supported by the gracility exhibited by several other South America Paleoindian male individuals (Mello e Alvim, 1977; Neves et al., 1999) and is also consistent with the material culture deposited in its grave.[2] However, an analysis of DNA extracted from Zuzu favored the interpretation of Lessa and Guidon (2002), i.e. that the skeleton belongs to a female individual.

Even though the discussion regarding Zuzu's sex has not yet been solved, its early date (early human skeletons are rarely found in the continent) justifies the study of its morphological affinities. Here we test the hypothesis that this individual will show stronger affinities with other samples of South American Paleoindians and Australo-Melanesians, as a consequence of the demonstrated morphological affinities between these groups (Neves and Pucciarelli, 1989, 1990, 1991; Powell and Neves, 1999; Neves et al., 2003, 2004, 2005, 2007; Gonzalez-José et al., 2003, 2005; Neves and Hubbe, 2005). However, because of the controversy regarding Zuzu's sex, its morphological affinities were analyzed in relation to males and females, separately.

Furthermore, since we had direct access to Zuzu's skeletal remains, we present here our own sex estimation of the specimen based on classic sexual diagnostic features (cranial and post-cranial indicators), complemented by a discriminant function analysis of Zuzu's cranial shape.

[2]Burial offerings included a series of lithic artifacts, among them four planoconvex scrapers and two bifacial projectile points (Guidon et al., 1998).

MATERIAL AND METHODS

During the exhumation of Zuzu, the skeleton and the surrounding sediment was embedded in B52 resin, allowing for its safe removal from the site. The embedded skeleton was then properly excavated in laboratory (Lessa and Guidon, 2002), but the B52 resin was not removed from the bone fragments at that point. Nelson (2005) describes how he curated the remains, which included removing the resin, reconstructing the skull, and refitting the face to the neurocranium. The reconstructed skull shows no evidence of artificial or taphonomic deformation, and thus is suitable for craniometrical analysis. Howells et al. (1973, 1989) protocol was used to measure the skull, and 34 measurements were taken. The names of the measurements and values obtained can be found in Table 1.

Zuzu's morphological affinities were assessed through two different morphological approaches. In the first, Zuzu was compared through cluster analysis to the worldwide morphological variation of the most significant principal components extracted from the database. In this case, the reference samples used were Paleoindians, Archaic Americans, and 18 Howells populations (Table 2), representing six regions in the world (Howells et al., 1973, 1989). The Paleoindian series comprises 39 skulls dated between 7.5 and 11.5 kyr BP from Lagoa Santa, central Brazil (see Neves and Hubbe, 2005, for details of this material) and 14 skulls from Sabana de Bogotá, Colombia, dated to between 11.0 and 6.0 kyr BP (Neves et al., in press). Although geographically set apart, these two regions present a high biological affinity, representing the only two large Paleoindian samples from single regions in the Americas (Neves et al., in press). The Archaic American series is comprised by 82 skulls recovered from two Brazilian coastal sites dated to around 1.0 kyr BP. This material shows a distinct morphology when compared to Paleoindians and have high morphological affinity with Amerindians (Neves and Hubbe, 2005). The second analysis considered the position of Zuzu in the morphospace of the individual dispersion of five key groups in the study of Paleoindian morphology: Paleoindians, Archaic Americans, Late Amerindians, Australo-Melanesians, and East Asians.

Since the sex of Zuzu is controversial, the individual was compared to two distinct data sets: one comprised of males and the other of females. In both analyses, skull size effect was corrected through the division of each variable value by the geometric mean of all variables for each individual (Darroch and Mosimann, 1985). Only the variables present in Zuzu were used. Consequently, no missing value replacement was necessary for this individual. However, for the Paleoindian and the Archaic American series, some missing value replacement was necessary (14.08% for males and 17.11% for females). Missing value replacement was done through the estimation of the absent measurement by multiple regressions of the total mean of the missing variable, using the other measurements as independent variables. To minimize the amount of missing value replacement, three variables were removed from the analyses since they were poorly represented among Paleoindians and Archaic

TABLE 1. Variables and measurement values from Zuzu

Variables[a]	Values (mm)
Glabello-occipital length (GOL)	183
Nasio-occipital length (NOL)	180
Basion-nasion length (BNL)[b]	101
Basion-bregma height (BBH)[b,c]	135
Maximum frontal breadth (XFB)	108
Bistephanic breadth (STB)[c]	105
Bizygomatic breadth (ZYB)[b,c]	126
Biauricular breadth (AUB)	116
Biasterionic breadth (ASB)	104
Nasal height (NLH)	45
Orbit height (OBH)	32
Bijugal breadth (JUB)	113
Nasal breadth (NLB)	25
Bifrontal breadth (FMB)	96
Biorbital breadth (EKB)[b]	96
Malar length, inferior (IML)[b]	36
Malar length, maximum (XML)[b]	52
Cheek height (WMH)	23
Foramen magnum length (FOL)[b]	37
Frontal cord (FRC)	102
Frontal subtense (FRS)	28
Nasion-subtense fraction (FRF)	48
Parietal cord (PAC)	112
Parietal subtense (PAS)	32
Bregma-subtense fraction (PAF)	58
Occipital cord (OCC)	98
Occipital subtense (OCS)	27
Lambda-subtense fraction (OCF)	45
Nasion radius (NAR)	92
Dacryon radius (DKR)[b]	86
Zygoorbitale radius (ZOR)[b]	87
Frontalmalare radius (FMR)	80
Ectoconchion radius (EKR)[b]	75
Zygomaxillare radius (ZMR)[b]	75

[a] Variable definition in accordance to Howells (1979, 1989).
[b] Variables excluded from the Discriminant analyses.
[c] Variables excluded from the Principal Component analyses.

TABLE 2. Reference populations' sample size and their geographic location

Series	Groups	Males (n)	Females (n)
LAGOA SANTA	Paleoindians	22	17
COLOMBIA	Paleoindians	6	8
BASE AEREA	Archaic Americans	13	11
TAPERA	Archaic Americans	29	29
ARIKARA	Amerindians	42	27
SANTA CR	Amerindians	51	51
PERU	Amerindians	55	55
TEITA	Africans	33	50
DOGON	Africans	47	52
ZULU	Africans	55	46
N JAPAN	East Asians	55	32
S JAPAN	East Asians	50	41
HAINAN	East Asians	45	38
AUSTRALIA	Australo-Melanesians	52	49
TASMANIA	Australo-Melanesians	45	42
TOLAI	Australo-Melanesians	56	54
NORSE	Europeans	55	55
ZALAVAR	Europeans	53	45
BERG	Europeans	56	53
MOKAPU	Polynesians	51	49
EASTER I	Polynesians	49	37
MORIORI	Polynesians	57	51
Total		977	892

Americans. Thus, the principal component analyzes were performed on 31 variables, as detailed in Table 1.

Principal components were extracted from the covariance matrix. The cluster analyzes were performed using Ward's Methods and the eight first principal components were used in each case (the number of principal components was selected based on the screeplots of their eigenvalues). The factor scores of the groups used to build the cluster were calculated as the mean score of the individuals assigned to it.

Sex estimation was performed through the morphological inspection of several classic skeletal features (Buikstra and Ubelaker, 1994), especially in the pelvis and the skull. The results of our observations were compared with the results obtained previously by Lessa and Guidón (2002) and by Nelson (2005). Besides visual inspection, Zuzu's cranial measurements were used in a discriminant analysis considering its most similar series as the reference population. Zuzu was then classified into one of the two possible groups (male or female) and posterior probabilities were calculated. Discriminant analysis was performed as a way to assess sex with a nonsubjective method. However, the analysis may be biased by the fact that most of the individuals used to calculate the discriminant functions were sexed based only on the skulls. This means that robust females and gracile males could have been incorrectly sexed by the investigators measuring it. In this case discriminant analysis should be expected to classify incorrectly such individuals as well. Thus, the discriminant analysis must be seen as complementary to the morphological inspection. Discriminant functions were calculated on size corrected data because of the fact that male Paleoindians are generally very gracile and that, for this reason, sexing of Paleoindian individuals relies more on shape features than on their size. This analysis was based on the 23 best represented variables, to minimize missing-value replacement. The variables used can be seen in Table 1. To test for the reliability of sex classification, the sex of individuals of the reference sample were also tested by cross-validation through discriminant analysis. In these cases, each individual was removed before the discriminant functions were computed, and then classified a posteriori, similar to what was performed with Zuzu.

RESULTS AND DISCUSSION

Morphological affinities

Figure 1 shows the cluster generated by the eight first principal components (resuming 74.87% of the original variation) extracted from the database that considers worldwide morphological variation, when Zuzu was compared with males. Zuzu associates itself with Colombia and Easter Island at the first level, and with Lagoa Santa, Australo-Melanesians and Africans at the second level. Amerindians and Archaic Americans can be found together with East Asians, Europeans, and the remainder Polynesians in the second large cluster. This pattern of associations clearly demonstrates the difference between Paleoindian groups and later American series, and is fully consistent with previous work on the subject (Neves and Pucciarelli, 1989, 1990, 1991; Powell and Neves, 1999; Neves et al., 2003, 2004, 2005, 2007; Gonzalez-José et al., 2003, 2005; Neves and Hubbe, 2005). The association between Zuzu and Easter Island is also within the expected, since the second is consid-

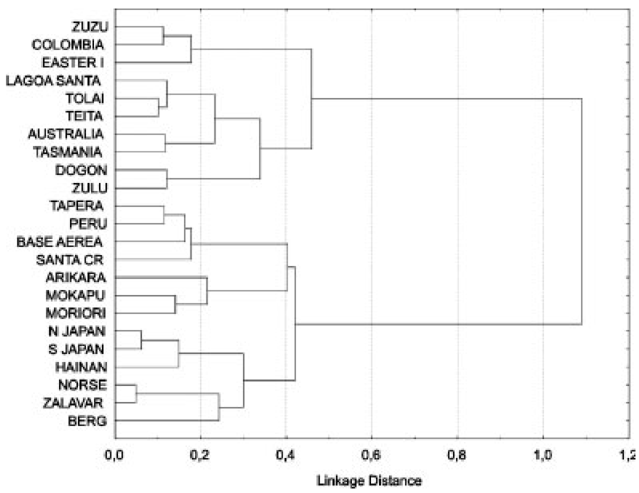

Fig. 1. Cluster (Wards method on Euclidean distances) based on the eight most significant principal components extracted from the male database.

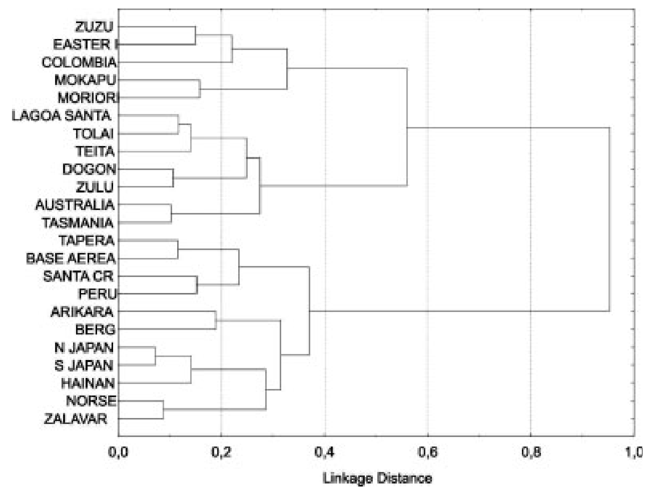

Fig. 2. Cluster (Wards method on Euclidean distances) based on the eight most significant principal components extracted from the female database.

ered as having retained a generalized morphology (Howells, 1973, 1989) and has been found associated with Paleoindians before (Neves and Hubbe, 2005; Neves et al., in press).

Figure 2 presents the same cluster (resuming 75.36% of the original variation) when Zuzu was compared to females. Distinct from what was observed when compared to males, in this analysis Zuzu is associated at the first level with Colombia and all Polynesian series, and at the second level with Lagoa Santa, Australo-Melanesians, and Africans. Again, Archaic Americans and Amerindians appear in another cluster, together with East Asians and Europeans. The difference observed in the previous analysis between Paleoindians and later American groups is clear here too, as well as the closer affinity between Zuzu and Paleoindians in relation to Archaic Americans and Amerindians. However, the preferential association between Zuzu and the Polynesian series denotes a closer affinity with Polynesian groups, considered as showing a morphology between Australo-Melanesians and Asians (Howells, 1973, 1989). Thus, this analysis suggests that when compared to females Zuzu shows a higher affinity to groups with a less generalized morphology than the previous ones, although clearly associated with the Paleoindian and Australo-Melanesian cluster.

Figure 3 shows the result of the principal component analysis comparing Zuzu to the male individual dispersion of the five groups selected. Zuzu appears clearly within the Paleoindian and the Australo-Melanesian 95% confidence ellipsis. It is also included in the East Asia dispersion, although very marginal, and completely out of the Amerindian distribution. It is clear in this analysis that while Paleoindians have a higher affinity with Australo-Melanesians, Archaic Americans and Amerindians show strong similarities with East Asians. Together, the two principal components used to construct Figure 3 explain 34.44% of the original variance. The correlations between the principal components and the original variables can be seen in Table 3. The first principal component has high positive correlations ($r > 0.50$) with cranial width (XFB and AUB) and occipital length (OCC and OCF), and high negative correlations ($r < -0.50$) with most of the facial radius (ZOR, ZMR, NAR, DKR, and FMR) and with inferior malar length (IML). The second principal component shows high positive correlations ($r > 0.50$) with occipital fraction (OCF) and high negative correlations ($r < -0.50$) with bi-auricular breadth (AUB) and bi-jugal breadth (JUB).

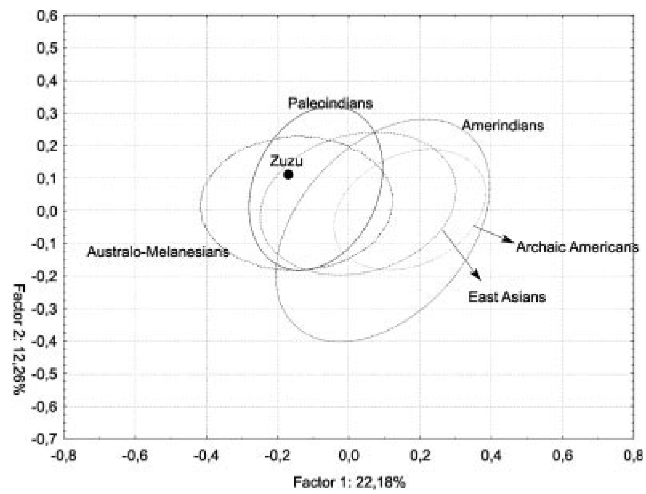

Fig. 3. Principal Component analysis depicting Zuzu's morphological affinities in relation to the male reference samples. The ellipses represent the 95% confidence range of the samples.

Figure 4 shows the same results when Zuzu was compared to females. Similar to the previous analysis, Zuzu appears clearly inserted in the Australo-Melanesian and Paleoindian dispersion. Zuzu also appears within the East Asia dispersion, but again very far from its centroid, and completely out of the Archaic American and Amerindian dispersion. It is clear, thus, that Zuzu shares a common cranial morphology with Australo-Melanesians and Paleoindians, and not with Asians, Archaic Americans, and Amerindians. Despite the results obtained in the analysis considering worldwide cranial variation, where Zuzu was classified with groups showing a morphology not as generalized as

TABLE 3. Correlation between the first two principal components and the original variables used in the analyses

Variables	Males		Females	
	Factor 1	Factor 2	Factor 1	Factor 2
Glabello-occipital length (GOL)	−0.304150	0.425709	−0.290591	**0.885256**
Nasio-occipital length (NOL)	−0.121492	0.422438	−0.120656	**0.900957**
Basion-nasion length (BNL)	−0.338409	−0.232205	−0.199739	−0.121206
Maximum frontal breadth (XFB)	**0.681721**	−0.274646	**0.630664**	−0.240976
Biauricular breadth (AUB)	**0.578490**	**−0.585817**	**0.644134**	−0.245473
Biasterionic breadth (ASB)	0.497105	−0.139545	**0.514686**	0.350522
Nasal height (NLH)	0.454785	−0.405114	0.492708	−0.256089
Orbit height (OBH)	0.496552	−0.270150	**0.562136**	−0.062976
Bijugal breadth (JUB)	0.190842	**−0.560198**	0.227763	−0.332535
Nasal breadth (NLB)	−0.343894	−0.116793	−0.359666	−0.108837
Bifrontal breadth (FMB)	−0.187229	−0.245948	−0.144839	0.065670
Biorbital breadth (EKB)	−0.118017	−0.291598	−0.116692	−0.037491
Malar length, inferior (IML)	**−0.532357**	−0.137861	−0.485737	−0.109132
Malar length, maximum (XML)	−0.229655	−0.291962	−0.200622	−0.308748
Cheek height (WMH)	0.337836	−0.153274	0.296925	−0.319477
Foramen magnum length (FOL)	0.197782	−0.255732	0.189078	0.009578
Frontal cord (FRC)	0.320654	0.084948	0.334231	0.216647
Frontal subtense (FRS)	−0.047782	0.227115	−0.121502	0.093946
Nasion-subtense fraction (FRF)	0.229763	−0.111780	0.170855	0.007803
Parietal cord (PAC)	−0.487937	0.321903	**−0.531240**	0.242178
Parietal subtense (PAS)	−0.241035	0.040764	−0.330475	−0.178194
Bregma-subtense fraction (PAF)	−0.222637	0.307757	−0.419737	−0.059481
Occipital cord (OCC)	**0.704680**	0.450941	**0.659070**	0.418084
Occipital subtense (OCS)	0.142632	0.469452	0.216851	**0.630547**
Lambda-subtense fraction (OCF)	**0.518362**	**0.524655**	**0.573613**	−0.004744
Nasion radius (NAR)	**−0.620546**	−0.245317	**−0.519321**	−0.033205
Dacryon radius (DKR)	**−0.551073**	−0.190403	−0.440134	−0.252000
Zygoorbitale radius (ZOR)	**−0.721618**	−0.059875	**−0.667588**	−0.243227
Frontalmalare radius (FMR)	**−0.540239**	−0.200376	−0.403945	−0.179828
Ectoconchion radius (EKR)	−0.464895	−0.141671	−0.401432	−0.322487
Zygomaxillare radius (ZMR)	**−0.648126**	−0.096589	**−0.599975**	−0.168671

In bold, highest correlations for each factor.

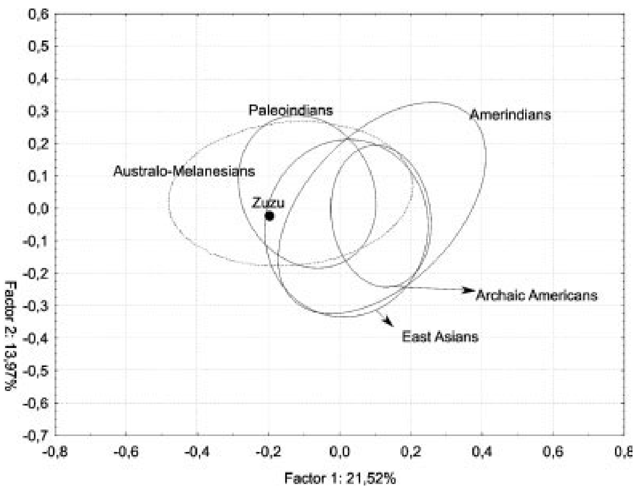

Fig. 4. Principal Component analysis depicting Zuzu's morphological affinities in relation to the female reference samples. The ellipses represent the 95% confidence range of the samples.

Australo-Melanesians, here its affinity is clearly stronger with these later groups, appearing in practically the same position in morphospace as was observed when it was compared to males. In this analysis, the first two principal components express 34.49% of the original variation and their correlation with the original variables can be seen in Table 3. The first principal component shows high negative correlations ($r < -0.50$) with some facial radius measurements (ZOR, ZMR, and NAR) and with parietal length (PAC) and high positive correlations ($r > 0.50$) with cranial breadth (XFB, AUB, and ASB), occipital length (OCC and OCF) and orbital height (OBH). The second principal component shows high positive correlations ($r > 0.50$) with cranial length (GOL and NOL) and occipital subtense (OCS).

The results obtained here, although based on an isolated individual, are congruent with the idea that at least two different biological populations participated in the occupation of the New World. It is clear that Zuzu shows stronger morphological affinities with the Paleoamerican samples used as reference (Lagoa Santa and Bogotá Savannah) than with the Archaic Americans and late Amerindian samples also used as reference. Furthermore, the closer affinity between Zuzu and Paleoindians extend considerably the known geographic range of the groups presenting Paleoamerican features during the Pleistocene/Holocene transition. With the results obtained here, it is clear that the morphological pattern that characterizes Paleoindians was dispersed throughout all South America.

Sex assignment

Table 4 details the sex estimation analysis performed by previous authors and by ourselves. Accordingly, Lessa and Guidon (2002) concluded that Zuzu was probably a female individual. Their conclusion is also supported by molecular data. Nelson (2005), after reconstructing part of the pelvis and the skull and comparing them with other human skeletal remains from the region, con-

TABLE 4. Resume of the results obtained in the sex estimation of Zuzu, according to each indicator observed by previous authors (Lessa and Guidon, 2002; Nelson, 2005) and by our analyses

	Lessa and Guidon, 2002	Nelson, 2005	This study
Final diagnosis	F?	M	M
Os coxae			
Ventral arc	F	M	M
Subpubic concavity	F	–	–
Sciatic notch	F[a]	M	M[b]
Preauricular sulcus	F	M	M
Sacrum			
Centrum-to-ala ratio	–	I	I
Skull			
Nuchal crest	–	I	F
Mastoid process	–	I	M
Supraorbital margin	M	-	M
Mental eminence	–	M	M
Long bone dimensions	–	F?[c]	F?[c]
Funerary context	M	–	–
DNA	F	–	–

M, Male; F, Female; I, Indeterminate; –, Not considered.
[a] Considered problematic due to the poor preservation of the individual.
[b] Left side, the best preserved one, is typical male, while right side is intermediate between male and female.
[c] When compared to Toca da Janela da Barra do AntoniĐo the individual fits better a gracile male.

cluded that Zuzu was a gracile male. In general, our own assessment of morphological sex indicators agrees with that of Nelson (2005), suggesting a gracile male specimen. This diagnosis is mainly supported by the features of the os coxae. Our main disagreement with Nelson relates to his opinion about the degree of development of the mastoid processes (intermediate in his view) in the skull. The left mastoid process, the best preserved of the two, although pointed, is clearly robust in our opinion and has a very marked supramastoid crest, reinforcing a male diagnosis. Another point of disagreement in the skull refers to the characteristics of the nuchal crest. While Nelson sees it as pointing to an intermediate sex, we believe they can be easily used to support a female diagnosis (only the immediate region around the inion presents a certain degree of rugosity).

With the morphological affinities of Zuzu established, the Paleoindian series could be used as reference samples for Zuzu's sex classification. Table 5 presents the results of the sex classification of Zuzu. As can be seen, Zuzu is classified as a male. The posterior probability (Table 5) strongly favors its classification into this category. Table 5 also shows the classification of all Paleoindian individuals. Twelve individuals (25.5%) were sexually misclassified. Although high, this percentage reflects the fact that the skull cannot be considered as reliable as the pelvis for sexing (White, 1991), especially in populations where males are generally gracile, as is the cases for Paleoindians. On the other hand, these results suggest that there is a 25% probability that the classification of Zuzu as a male is wrong. However, posterior probabilities for incorrectly classified skulls tend to be smaller (0.8624 $\pm$ 0.1832) than for the correctly classified ones (0.9357 $\pm$ 0.1190), and there is only one incorrectly classified skull with higher posterior probability than Zuzu. Thus, when posterior probabilities are considered the reliability of the classification obtained for this individual is strengthened.

TABLE 5. Classification of Zuzu and the paleoindian individuals according to sex and the associated posterior probabilities

Individual	Observed sex	Classification	Posterior probability
ZUZU	–	Masc	0.999514
CH10	Masc	Masc	0.918874
TEQI02	**Masc**	**Fem**	**0.984676**
TEQI03	Masc	Masc	0.598236
TEQI12	Masc	Masc	0.999951
TEQI13	**Masc**	**Fem**	**0.986501**
TEQI16	Masc	Masc	0.999680
MN 629	Masc	Masc	0.999544
MN 630	**Masc**	**Fem**	**0.594934**
MN 804	Masc	Masc	0.999872
MN 805	Masc	Masc	0.997815
MN 807	Masc	Masc	0.969943
MN 1355	Masc	Masc	0.999006
MN 1357	Masc	Masc	0.999971
HW 002	Masc	Masc	0.999937
HW 010	**Masc**	**Fem**	**0.864030**
HW 014	Masc	Masc	0.967828
CONFINS	**Masc**	**Fem**	**0.998392**
SR11	Masc	Masc	0.999999
SH02	Masc	Masc	0.676266
SH03	Masc	Masc	0.999914
SH04	Masc	Masc	0.997756
SH05	Masc	Masc	0.830140
SH09	**Masc**	**Fem**	**1.000000**
SH10	Masc	Masc	0.999997
SH11	Masc	Masc	0.999961
SH16	Masc	Masc	0.609644
CH07	Fem	Fem	0.962307
CH13	Fem	Fem	0.994835
GACHASN	Fem	Fem	0.967434
TEQI07	**Fem**	**Masc**	**0.599121**
TEQI18	Fem	Fem	0.651888
TEQII01	Fem	Fem	0.852984
TEQII02	Fem	Fem	0.999861
TEQII03	Fem	Fem	0.931765
MN 806	**Fem**	**Masc**	**0.996955**
MN 1325	Fem	Fem	1.000000
MN 1353	Fem	Fem	0.998838
MN 1388	Fem	Fem	0.985883
MN 1959	**Fem**	**Masc**	**0.904362**
HW S/N	**Fem**	**Masc**	**0.515356**
HW 001	Fem	Fem	0.999864
HW 004	**Fem**	**Masc**	**0.996524**
HW 005	Fem	Fem	0.809148
SR13	Fem	Fem	0.996982
SH07	Fem	Fem	0.979008
SH08	**Fem**	**Masc**	**0.907919**
SH15	Fem	Fem	0.999906

In bold, individuals classified incorrectly.

CONCLUSIONS

The aim of this brief communication was twofold: to assess the morphological affinities of the human skeleton from Toca dos Coqueiros, a.k.a. Zuzu, and also to contribute to the controversy generated by previous researchers (Lessa and Guidon, 2002; Nelson, 2005) regarding the sex of the individual. Regarding the first aim, our results clearly demonstrate a strong morphological affinity between Zuzu and other early South American series, as well as a Paleoamerican morphology. So far, all skulls older than 7.5 kyr BP known in South America (and Central America) share this morphological pattern. Zuzu demonstrates that this morphology was also present in Northeastern Brazil during the Pleistocene/Holocene transition.

Regarding Zuzu's sex, our analyzes support the idea defended by Nelson (2005) that this skeleton belongs to a gracile male. Nonetheless, it remains to be explained why the DNA analysis reported by Lessa and Guidon resulted in a female classification. We agree with Nelson (2005) that anatomical evidence supporting a male classification seriously challenges the reliability of the molecular results presented by Lessa and Guidon (2002). Although molecular analysis is usually seen as more reliable than morphological inspection, the coincidence between the morphological inspections performed by Nelson (2005) and by ourselves and the multivariate analysis presented here cast still more doubts on the molecular data presented by Lessa and Guidon (2002). We believe there is now enough evidence corroborating a male assignation for Zuzu that justifies another run of molecular data to see if the previous results were influenced by laboratory contamination.

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LITERATURE CITED

Buikstra JE, Ubelaker D, editors. 1994. Standards for data collection form human skeletal remains. Arkansas Archaeological Survey Research Series 44. Arkansas: Arkansas Archaeological Survey.

Darroch JN, Mosimann JE. 1985. Canonical and principal components of shape. Biometrika 72:241–252.

González-José R, González-Martín A, Hernández M, Pucciarelli HM, Sardi M, Rosales A, Van der Molen S. 2003. Craniometric evidence for Palaeoamerican survival in Baja California. Nature 425:62–65.

González-José R, Neves WA, Lahr MM, González S, Pucciarelli H, Martinez MH, Correal G. 2005. Late Pleistocene/Holocene craniofacial morphology in Mesoamerican Paleoindians: implications for the peopling of the New World. Am J Phys Anthropol 128:772–780.

Guidon N, Parenti F, Oliveira C, Vergne C. 1998. Nota sobre a sepultura da Toca dos Coqueiros, Parque Nacional Serra da Capivara, Brasil. Rev Clio Ser Arqueol 13:187–197.

Howells WW. 1973. Cranial variation in man: a study by multivariate analysis of patterns of difference among recent human populations. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 67. Cambridge: Harvard University.

Howells WW. 1989. Skull shapes and the map. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 79. Cambridge: Harvard University.

Hubbe M., Neves WA, Atui JPV, Cartelle C, Silva MP. 2004. A new early human skeleton from Brazil: further support to the "two main biological components model" for the settlement of the Americas. Cur Res Pleist 21:77–81.

Lessa A, and Guidon N. 2002. Osteobiographic analysis of skeleton I, Sítio Toca dos Coqueiros, Serra da Capivara National Park, Brazil, 11,060 BP: first results. Am J Phys Anthropol 118:99–110.

Mello e Alvim MC. 1977. Os antigos habitantes da área arqueological de Lagoa Santa, Minas Gerais, Brasil—estudo morfológico. Arq Mus Hist Nat 2:119–166.

Nelson AR. 2005. "Osteobiographics" of Dos Coqueiros Paleoindian reconsidered: comment on Lessa and Guidon (2002). Am J Phys Anthropol 126:401–403.

Neves WA, González-José R, Hubbe M, Kipnis R, Araújo AGM, Blasi O. 2004. Early human skeletal remains form Cerca Grande, Lagoa Santa, Central Brazil, and the origins of the first Americans. World Archaeol 36:479–501.

Neves WA, Hubbe M. 2005. Cranial morphology of early Americans from Lagoa Santa, Brazil: implications for the settlement of the New World. Proc Natl Acad Sci USA 102: 18309–18314.

Neves WA, Hubbe M, Correal G. Human skeletal remains from Sabana de Bogotá, Columbia: a case of Paleoamerican morphology late survival in South America? Am J Phys Anthropol, in press.

Neves WA, Hubbe M, Okumura MMO, González-José R, Figuti L, Eggers S, De Blasis PAD. 2005. A new early Holocene human skeleton from Brazil: implications for the settlement of the New World. J Hum Evol 48:403–414.

Neves WA, Hubbe M, Piló LB. 2007. Early Holocene human skeletal remains from Sumidouro Cave, Lagoa Santa, Brazil: history of discoveries, geological and chronological context, and comparative cranial morphology. J Hum Evol 52:16–3.

Neves WA, Powell JF, Ozolins EG. 1999. Extra-continental morphological affinities of Palli Aike, southern Chile. Interciencia 24:258–263.

Neves WA, Prous A, González-José R, Kipnis R, Powell JF. 2003. Early human skeletal remains from Santana do Riacho, Brazil: implications for the settlement of the New World. J Hum Evol 45:19–42.

Neves WA, Pucciarelli HM. 1989. Extra continental biological relationships of early South American human remains: a multivariate analysis. Ciência e Cultura 41:566–575.

Neves WA, Pucciarelli HM. 1990. The origins of the first Americans: an analysis based on the cranial morphology of early South American human remains. Am J Phys Anthropol 81:247.

Neves WA, Pucciarelli HM. 1991. The origin of the first Americans: an analysis based on the cranial morphology of early South American human remains. J Hum Evol 21:261–273.

Powell JF, Neves WA. 1999. Craniofacial morphology of the first Americans: pattern and process in the peopling of the New World. Yrbk Phys Anthropol 42:153–188.

White, T. 1991. Human Osteology. San Diego: Academic Press.