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Craniometrical analysis of Central and East Africans in relation to history

A case study based on unique collections of known ethnic affiliation

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Abstract

The main objective of the present research is to explore in a historical perspective the craniometrical diversity of two modern Bantu-speaking sub-Saharan African populations of known ethnic origin. These groups originating from Central Africa (Basuku) and East Africa (Bahutu) are both historically- and linguistically-related: they are most probably the descendants of earlier West-Central African agriculturalists, who expanded on a large-scale within sub-Saharan Africa since the Early Iron Age (around 1000 BC).

After replacing the two groups under focus within the variation of the African continent as well as analysing their similarities, the following question is addressed: do the Basuku and Bahutu morphology reflect the homogenizing effects of the expansion of Bantu-speakers and/or additional factors such as a differentiation in relation to geography?

In order to test this issue, the largest modern African sample available so far and originating from different regions is used for comparative purposes. A set of metric traits related to the different parts of the cranium is also analysed through univariate and multivariate statistics. The results reveal the following facts:

- the Bahutu are always located in the middle of the comparative sample and they are very close to their region of origin, in contrast to the Basuku;
- in both Basuku and Bahutu, the size and shape of vault is very similar, but a few facial features differ;
- as the Bantu-speakers do not cluster together systematically, it is difficult to support homogenization as the single process resulting from a large dispersal.

In conclusion, the results reveal that it is difficult to interprete the diversity in relation to only one historical event. They suggest however that the two streams of the Bantu-speakers dispersal could have diversified according to many other factors (geographical barriers, time scale). In particular, the higher levels of variation observed within the Central Africans (including the Basuku) could perhaps support linguistic data about a greater antiquity for the west-central stream, which evolved earlier than the eastern one.

Résumé

Analyse craniométrique de Centre et Est Africains dans une perspective historique : une étude de cas sur des collections uniques d'origine ethnique connue.

La présente recherche a pour objectif principal l'exploration dans une perspective historique de la diversité craniométrique de deux populations contemporaines de l'Afrique sub-Saharienne de langue bantoue et d'origine ethnique connue. Ces groupes provenant de l'Afrique Centrale (Basuku) et de l'Afrique de l'Est (Bahutu) sont étroitement liés du point de vue à la fois historique et linguistique : ils représentent le plus probablement les descendants des premiers agriculteurs Ouest-Centre Africains, qui se sont répandus à grande échelle à l'intérieur de toute l'Afrique sub-Saharienne depuis la période de l'Âge du Fer Ancien (autour de 1000 av. J.-C.).

Après avoir replacé les deux groupes sous étude au sein de la variation du continent Africain et analysé leurs ressemblances, la question suivante est posée : est-ce que la morphologie des Basuku et des Bahutu reflète une homogéinisation, conséquence de l'expansion des peuples de langue bantoue, et/ou d'autres facteurs supplémentaires tels qu'une différentiation en relation avec la géographie ?

Afin de tester cette question, le plus large échantillon possible d'Africains contemporains provenant de diverses régions est utilisé à des fins comparatives. Une série de caractères métriques liés à différentes parties du crâne est aussi analysée grâce à des statistiques univariées et multivariées. Les résultats révèlent les faits suivants :

- *les Bahutu sont toujours localisés au milieu de la variation de l'échantillon de comparaison, et ils sont très proches de leur région d'origine, par opposition aux Basuku ;*
- *chez les Basuku et les Bahutu, la taille et la forme du crâne est très similaire, mais certains caractères de la face diffèrent ;*
- *comme les peuples de langue bantoue ne se regroupent pas systématiquement, il est difficile de supporter l'hypothèse d'une homogéinisation en tant que seul processus résultant d'une expansion à grande échelle.*

En conclusion, les résutalts révèlent la difficulté d'interpréter la diversité en relation avec un seul évènement historique. Ils suggèrent cependant que les deux courants de l'expansion bantoue ont pu se diversifier en fonction de plusieurs autres facteurs (barrières géographiques, échelle temporelle). En particulier, les niveaux élévés de variation présents chez les Centre Africains (incluant les Basuku) pourraient supporter les données linguistiques au sujet d'une plus grande antiquité du courant centre-occidental ayant évolué plus tôt que le courant oriental.

1. INTRODUCTION

1.1. Objectives

The objective of the present research is the craniometrical analysis of two modern sub-Saharan African groups in relation to their historical background. These skeletal collections, which are housed at the *Institut Royal des Sciences Naturelles de Belgique* (IRScNB) in Brussels are unique, as they are well-documented. According to museum archives, their ethnic affiliation is precisely reported to be in both Central Africa (Basuku) and Eastern Africa (Bahutu). In fact, this kind of information on modern cranial series is rarely found in museum archives.

Concerning the morphological variation of both Basuku and Bahutu crania, a series of three questions are addressed:

- On a broad inter-regional level, how do these two Central and Eastern African groups of known ethnic affiliation fit within the African diversity, using for the first time the largest data set available so far?
- On a more detailed level, what is the nature of the similarities and differences between the Basuku and the Bahutu?
- And, are these observed similarities of both Basuku and Bahutu with other groups high enough to be considered as the result of homogenization processes due to the expansion of Bantu-speakers into sub-Saharan Africa?

The first two questions will help us to replace more precisely within a broad geographical framework the variation of these two cranial series that are here analysed for the first time. And, the last one will also enable us to link the results obtained with a major historical event, which probably involved at least 3000 years ago the ancestral populations of the two modern groups under focus.

1.2. Key aspects for interpreting craniometrical variation: geography, selective pressures and history

Before starting analysis, it is important to review the key aspects for interpreting craniometrical variation. According to previous literature (Howells, 1989; Lahr, 1996; Froment, 1998), geography, selective pressures and history are the main aspects responsible for the variation of skull morphology both on a worldwide scale and within a continent. These three recent studies cited above showed the two following facts: the differentiation of modern populations reflects first geography, which can promote or stop gene flow; and, not only vault features but also various facial ones, are responsible of both inter- and intra-regional differences.

For example, using various samples (Teita, Dogon, Zulu, Bushman) (N = 373), Howells (1989) noted that, on a worldwide scale, sub-Saharan African crania are characterized by the following morphological features: narrow cranial base; very convex frontal; narrow and short face; large breadth across nose, eyes and face; and face bowed forward without nasal prominence. As already suggested by Howells (1989), Lahr (1996) also showed that sub-Saharan Africans can have the most gracile skulls. For example, the latter (originating mainly from Eastern Africa) present in general a low development of robusticity features.

In comparison to previous authors, Froment (1992a, 1992b, 1998) evidenced more precisely the regional diversity, which is present within sub-Saharan Africa, especially Western Africa. In fact, he used a larger data set obtained from compiled publications (N = 531) that were more representative of all regions. The author observed marked differences in vault breadth between the following groups: Southern Africans (Zulu) and Western Africans (various Cameroonians) with broadest crania, and Eastern Africans (Teita) and other Western Africans (Ashanti) with narrowest crania.

In fact, multivariate analyses of both Howells (1989) and Froment (1992a, 1992b) agreed on the following points: Africans present the highest levels of diversity on a worldwide scale, as also suggested by demographic models that combined both genetic and craniometrical data (Relethford & Harpending, 1994; Eller, 2001); and this marked geographical differentiation is best shown when using cranial variables related to breadth of face and nose.

In addition to geography, population differentiation can be also affected by other factors such as both selective pressures and history, as it has been previously suggested by various other craniometric analyses (Hiernaux & Froment, 1976; Hiernaux, 1974, 1976; Rightmire, 1972). However, the effects of these two factors are difficult to identify and to distinguish between each other, especially when they follow the same geographical trend.

Firstly, concerning the influence of ecology on head shape, previous works (Hiernaux &

Froment, 1976; Howells, 1989) showed that several features especially facial traits might be under the control of strong selective pressures. For example, on a worldwide scale, Hiernaux & Froment (1976) identified a relatively high correlation between nasal breadth and average rainfall (r = 0.4). Narrow noses appear to work better as a humidifier for dry air, as it was already suggested by Davies (1932), Weiner (1954) and Thomson & Buxton (1923). In fact, according to various other anthropometrical data on living populations, Hiernaux (1974) also noted that, nasal breadth is part of a series of morphological features (trunk length, limb proportions) reflecting "climatic" adaptation to wet and dry areas along the equator.

Nevertheless, adaptation of head shape to climatic factors as the result of a strict causal relationship is difficult to demonstrate, especially on small time depth and geographical scale. In particular, the question of morphological adaptation to ecology will not be explored here, as the sample under focus originating from both Central Africa and Eastern Africa does not correspond to a very high diversity of environments. Furthermore, as the hypotheses of a "climatic" adaptation of the skull shape remain very speculative so far, the present study will explore other factors such as geography and history.

Secondly, concerning the effects of history on head shape such as large-scale events within sub-Saharan Africa, the expansion of Bantu-speakers is one of the key issue to explore. So far, it is documented by three areas of research: linguistics, archaeology and genetics.

According to Heine (1980) and Bastin *et al.* (1983), it is firstly a linguistic phenomenon: Bantu (or Benue-Congo) languages have a wide distribution that probably originated from West-Central Africa. Because of the linguistic affinities observed throughout all Bantu-speaking sub-Saharan area, this phenomenon could result from a large-scale dispersal. If languages spread simultaneously to a movement of populations, this expansion also corresponds therefore to a biological reality. However, if languages spread only by cultural diffusion, there is no migratory event and therefore no gene flow.

In this respect, archaeological evidence indirectly supports the first option, where there is an exchange of both cultural and biological aspects. Simultaneously to this linguistic phenomenon, various (semi-) sedentary populations seemed to have spread throughout all sub-Saharan Africa (de Maret, 1977; Clist, 1991; Vansina, 1995). In fact, an increasing number of settlements providing evidence of a (semi-) sedentary way of life have been discovered. Their dates about the beginnings of the dispersal (around 3000–1000 BC) also seem to agree with linguistic data. This cultural diffusion appeared however to be a complex process of sedentism associated with different kinds of food productions (horticulture, agriculture, pastoralism), which probably emerged subsequently to various demographic pressures (Clark, 1980; David, 1980; Van Bakel, 1981).

Finally, data obtained from different genetic systems also support the dispersal of Bantu-speakers and the founder effect phenomenon resulting from the latter (Cavalli-Sforza *et al.*, 1994; Bandelt *et al.*, 1995; Pereira *et al.*, 2001; Underhill *et al.*, 2001). In fact, they found the presence (although not systematically) of common genetic markers throughout sub-Saharan Africa, especially within Bantu-speaking populations.

Assuming that these key results together with the linguistic, archaeological and genetic data support the historical event of the Bantu-speakers expansion, the following question is raised: how can we interpret the morphological patterns observed in the context of that event?

According to Hiernaux (1976), its biological effects are visible through a general process of morphological homogenization. This fact was also observed by Froment (1992a, 1992b) and Ribot (2002), who analysed a wider range of craniometrical features amongst both Bantu-speakers and other linguistic groups.

Despite the traces of a founder effect phenomenon, a regional diversification reflecting the various streams for the Bantu dispersal, could also have occurred. This other hypothesis was shown on an inter-ethnic level by Rightmire (1972), who identified the advance of the Bantu-speakers expansion in both Eastern Africa and Southern Africa. On an inter-regional level, Ribot (2002) also observed traces of a two main streams phenomenon into West-Central Africa and Eastern Africa, which however could also reflect various other confounding factors (geography, modern micro-scale dispersals).

Therefore the possibly combined effects of both geography and a large-scale historical event on skull morphology diversification will be explored here, not through time but as a final result in modern populations. Focusing on two populations from both Central Africa and Eastern Africa, it will allow us to re-evaluate the differences and/or similarities of sub-Saharan Africans, both belonging broadly to the same linguistic branch and sharing similar historical roots dated to the Mid- and Late Holocene.

2. MATERIALS

A total sample of 1659 individuals originating mainly from modern sub-Saharan Africa forms the empirical basis of this study (fig. 1, Annex 1). Table 1 shows a summary description of materials: the two groups under focus and the comparative modern sample defined on a broad inter-regional level. The sample consists of data, which have been both compiled from nineteen papers in the literature (62%) and collected by the author (38%) during the PhD dissertation (Ribot, 2002).

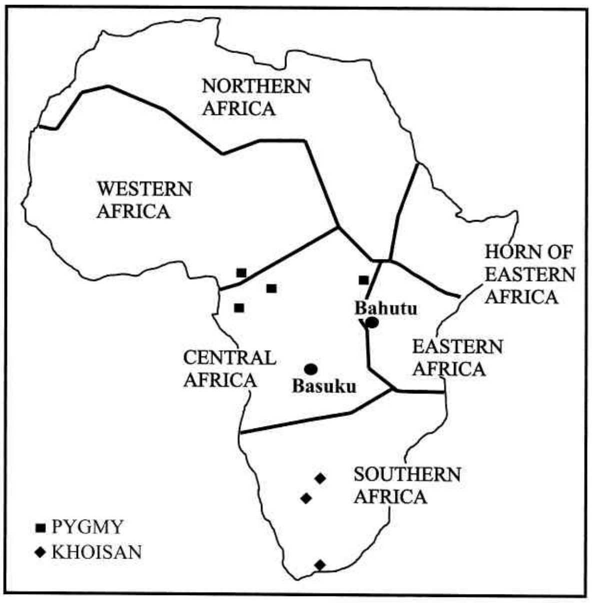

Fig. 1 — Geographical distribution of the populations under study within Africa and the major inter-regional subdivisions.

2.1. The two groups under focus

The cranial series of the two groups under focus such as the Basuku and the Bahutu are relatively well-documented in comparison to other modern African samples. The ethno-historical information found at the IRScNB (*Anthropologie & Préhistoire*) is therefore presented here, adding a few other data on general aspects of the populations themselves (language, economy, kinship, history).

According to the notes of Bequaert, who was Conservator at the Royal Museum of Central Africa in Tervuren during the fifties of the 20th century AD, the Congolese sample of Basuku crania (N = 144) was found by Van de Ginste. As the latter was carrying an anthropometrical study on living populations in the territory of Feshi (south-west of DRC) [Van de Ginste, 1946], he collected progressively the crania from various isolated burials of the

Origin of sample	N° of individuals			Bantu-speakers in %[1]
	compiled data	personal data	total sample	
Well-documented groups under focus				
Basuku (DRC)	–	144	144	100
Bahutu (Rwanda)	–	89	89	100
Comparative African sample				
Main regions:				
Western Africa	139	277	416	30
Central Africa (excluding Pygmies)	224	32	256	99
Eastern Africa	350	38	388	55
Horn of Eastern Africa	35	23	58	0
Southern Africa (excluding Khoisan)	112	–	112	100
Northern Africa	65	–	65	0
Historic foraging groups:				
Pygmy	16	5	21	100
Khoisan	89	21	110	0

[1] It is a minimal percentage, as information about linguistic affiliation is not always available.

Table 1 — List of the groups under study (pooled sexes).

same area. These findings are probably very recent, dated to approximately the last two centuries.

According to Van de Ginste, this sample also belongs to the Basuku (or Suku), who represent the dominant group in the Kwango district (long. 17–18° E and lat. 5–6° S). However, the hypothesis that a few other ethnic groups (Batsamba, Bawongani, Bapende, Baluwa-Basonde) could be present in the sample, cannot be excluded completely. According to the notes of Bequaert, all of them are very close to the Basuku in many aspects (habitat, language, origin, customs), although the Baluwa-Basonde might present some differences.

According to historical and ethnographical data (Van de Ginste, 1946; Yakan, 1999), both Basuku and Batsamba probably result from one of the earliest waves of the Bantu-speakers expansion, which started from West-Central Africa into Central Africa since at least the first millenium BC. More recently, they originated from the Congo kingdom: since the 16th–18th centuries AD, they migrated southward to the Kwango district, where they found peoples such as the Bawongani and Bapende. In the 16th century AD, the Bapende were strongly influenced by the kingdom of Lunda. By the end of the 19th century AD, the Basuku also came into contact with Portuguese traders and settlers, and nowadays they have undergone influence of mainly (Ba-)Kongo people from the Kasai region. The Basuku and all their neighbouring groups, who speak a west-central Bantu language are also essentially agriculturalists (Holden, 2001). In addition, the Batsamba are blacksmiths, but they do not own land apart from their house and fields, in contrast to the Basuku. Both Batsamba and Basuku are matrilineal societies, with royal lineages for the last group.

Two series of Bahutu (or Hutu) crania (N = 89) originating from Rwanda are also available at the IRScNB.

The first one corresponds to a small sample (N = 15) collected by R. Van Saceghem between 1922 and 1935 in the Bugoye region (Kissenyi territory). These Bahutu crania were found on small islands of Lake Kivu that were used as cemeteries for women, who died during pregnancy.

The second collection corresponds to a much larger series of crania (N = 74) collected by N. Nenquin in 1960 during his scientific expedition in Rwanda. According to his notes in the archives of the Royal Museum of Central Africa in Tervuren that were sent to Brabant (1963), he found the crania in a volcanic cave close to the city of Ruhengeri. According to the notes of Nenquin, these crania most probably belonged to a Bahutu group, who was hiding in the surroundings of the cave in order to escape from the German district during the First World War of 1914–1918. They are therefore dated to approximately less than a century ago.

According to historical and ethnographical data (Murdock, 1959; Yakan, 1999), the Bahutu are mainly concentrated in Rwanda and speak an eastern Bantu language. They also derive from one of the various waves of the Bantu-speakers expansion, as around the 2nd century AD they probably migrated from the Chad-Niger region to the area of Burundi-Rwanda forcing the previous inhabitants (Twa pygmies) to retreat. Between the 14th and 18th centuries AD, the Bahutu were subjugated by the Tutsi, who, arriving from the Nile valley or Ethiopia, set up a system of feudal classes. Although they adopted cattle from the Tutsi, the Bahutu are still mainly agriculturalists. Their society is also based on patrilineal clans ruled by kings.

2.2. The comparative African sample

Eight other African groups, which are defined broadly on either regional or ethnic origin, are used here for comparative purposes (N = 1426).

On a broad inter-regional level, the comparative sample is subdivided into the following six groups: Western Africa (including West-Central region such as Cameroon and Nigeria), Central Africa (excluding Pygmies), Eastern Africa, Southern Africa (excluding Khoisan), the Horn of Eastern Africa, and Northern Africa (only western areas) [fig. 1, table 1]. These groupings allow us to perceive the broad geographical origin of each sub-sample within sub-Saharan Africa (first four regions) and the rest of Africa (last two regions). In fact, the Horn of Eastern Africa is not considered here as part of sub-Saharan Africa, as most of the populations have been highly admixed with Afro-Asiatic speaking groups originating from the Middle East. Although these groups are approximate, they are based on the existence of physical geographical features or natural barriers observed all over the African continent. In fact, this classification has been already used by other authors for ethnographical purposes (Giles *et al.*, 1997).

In addition, two historic foraging groups such as Pygmies and Khoisan are always treated separately from their region of origin. In fact, they cannot be classified into a purely geographical framework, as in historical terms they correspond to groups that are not related to the Bantu-speakers expansion. They represent autochthonous populations, who were already settled in sub-Saharan Africa previous to the dispersal of Bantu-speakers. And according to previous data (Hiernaux, 1976; Morris, 1986; Froment, 1993), they are still biologically very different from all other groups despite some possible admixture.

According to Greenberg's classification (1964), most of the populations under study here belong to the largest linguistic phylum present within Africa (Niger-Congo-speakers: 71%) as well as to the largest linguistic sub-set of the latter (Benue-Congo- or mainly Bantu: 58%) [table 1]. Two other linguistic families are represented by the following regional groups: Northern Africa and Horn of Eastern Africa (Afro-Asiatic), and Khoisan (Khoisan).

3. METHODS

3.1. Sex determination

Most of the crania under study (59%) are of male sex (N = 975), and the remaining ones of female sex (N = 684).

Concerning the compiled data, no information is available about the methods used for sex determination. However, concerning the personal data, sex is assessed morphologically according to the methods used by Ferembach *et al.* (1980), although the skull does not provide the most reliable features related to sexual dimorphism. As the sex-related morphological traits dealing essentially with robustness are recommended especially for European populations, some of them had to be slightly adapted to African populations. For example, the frontal inclination is not considered here, because both females and males amongst Africans often tend to present a full rounded frontal contour (Krogman & Iscan, 1986).

3.2. Metric traits

Thirteen cranial measurements devised by Martin & Saller (1959) and Howells (1989) are used (table 2). Nearly half of the variables correspond to the vault (6 variables), and all remaining ones are related to the face (7 variables). Measurements were taken to the nearest millimeter on both sides, using two instruments (sliding and spreading calipers).

Concerning the compiled publications (Annex 1), agreements for each measurement definition have been reviewed in various scientific reviews of anthropometry (*Biometrika*, *Archiv für Anthropologie*), as well as in several reference manuals (Martin & Saller, 1959; Howells, 1989).

3.3. Statistical methods used

In order to assess differences and similarities between the groups under focus and the comparative sample, both univariate (one-way analysis of variance, independent sample t-test) and multivariate (factor analysis) statistics are performed here. The SPSS (version 9.0) and SYSTAT (version 8.0) softwares are used for this purpose.

In particular, factor analysis (Principal Component analysis or PCA) will help us to assess similarities between populations, as it seeks to identify common underlying patterns of variation (Pietrusewsky, 2000). It identifies a relatively small number of factors that can be used to represent indirectly observable relationships among sets of inter-related variables. According to PCA, successive linear combinations of variables are therefore extracted, progressively accounting for smaller portions of variance in the sample.

Furthermore, in order to visualize the distribution of the sample in a multivariate space and localize more precisely the groups under focus within the variation, scatterplots of regression factor scores are also drawn with an ellipse of confidence ($p = 0.7$) for each group ($N \geqslant 20$).

4. UNIVARIATE STATISTICS

Before statistical analysis, all sample is checked for normality, using stem-and-leaf displays and tables for testing and eliminating

Broad anatomical location	Description of variable	Code of Shrubsall (1898)	N° of Martin & Saller (1959)	Code[1] of Howells (1989)
VAULT	maximum vault length (*glabella – opisthocranion*)	L	1	GOL
	maximum vault breadth (between parietals)	B	8	XCB
	total vault height (*basion – bregma*)	H′	17	BBH
	frontal chord (*nasion – bregma*)	S1′	29	FRC
	parietal chord (*bregma – lambda*)	S2′	30	PAC
	occipital chord (*lambda – opisthion*)	S3′	31	OCC
FACE	facial length (*basion – nasion*)	LB	5	BNL
	facial length (*basion – prosthion*)	GL	40	BPL
	upper facial height (*nasion – prosthion*)	G′H	48	NPH
	minimal frontal breadth (between *frontotemporalia*)	B′	9	WFB
	maximal nasal breadth (*alare – alare*)	NB	54	NLB
	orbital breadth (*ectoconchion – dacryon*)	O1′	51a	OBB
	bizygomatic breadth (between zygomatic arches)	J	45	ZYB

[1] These variable codes are used in the present study.

Table 2 — List of the cranial metric traits under study.

major skewness (Zar, 1984). Two preliminary tests are also performed on the individual variables.

Firstly, cranial morphology is tested in relation to differences reflecting sexual dimorphism. Although the latter are probably less marked than geographical differences, they have to be taken into account and evaluated more precisely within each group.

Secondly, morphological similarities and differences are also tested in relation to the different groups and regions under study. It provides to us a preliminary indication of the most and the least discriminatory power of the individual variables.

4.1. Independent sample t-tests

Mean differences for the 13 craniometrical variables are tested between male and female samples, when a minimal number of individuals ($N \geqslant 20$) is available within each group. The results of the t-tests are summarized in Annex 2 that also includes descriptive data. Most of them are significant (at varying levels of probability). Only 7 t-tests (over 101 in total) appear to be not significant, especially for the variable OCC and sometimes for three other ones (BNL, NLB, WFB).

Therefore, within the various groups and regions, most of the measurements under study except for a few cases are affected by sexual dimorphism at various degrees. In order to avoid biases not related to geographical origin, this result favours the procedure of treating sexes separately in subsequent statistical analyses.

4.2. One-way analyses of variance

In order to test the equality of means amongst the groups under study, the one-way analyses of variance are performed. As a minimal number of individuals ($N \geqslant 20$) is needed, the number of compared groups varies and the Pygmies have never been included in the analyses. The results for all variables in both male and female samples are presented in table 3, ranking the F-values from the highest to the lowest ones.

For both males and females, the results are basically the same. Most of the variables show significant differences between most of the groups. The variable BBH presents always the highest F-value. Five other variables (OBB, NLB, ZYB, XCB, GOL) are also highly ranked although in a variable order. Four variables (FRC, OCC, WFB, PAC) always show the lowest F-values, but two other ones (BNL, NPH) are ranked in a very variable manner according to the sex under study. For example, the variable NPH has a slightly higher discriminatory power in females than in males.

The significance of the Levene's test only provides here an indication about the skewness of a variable (Leguebe, pers. comm.). It tests the homogeneity of variance, but it is based

	Variables	N	F	Sig.[1]	L.[2]	Groups compared[3]
Males	BBH	820	37.17	***	NS	BAS, BAH, WA, CA, EA, H, SA, NA, K
	OBB	756	21.76	***	NS	BAS, BAH, WA, CA, EA, H, SA, NA, K
	NLB	868	20.36	***	NS	BAS, BAH, WA, CA, EA, H, SA, NA, K
	ZYB	738	19.46	***	NS	BAS, BAH, WA, CA, EA, H, SA, NA, K
	XCB	915	17.34	***	*	BAS, BAH, WA, CA, EA, H, SA, NA, K
	GOL	923	16.65	***	NS	BAS, BAH, WA, CA, EA, H, SA, NA, K
	BNL	845	16.50	***	NS	BAS, BAH, WA, CA, EA, H, SA, NA, K
	BPL	777	14.21	***	NS	BAS, BAH, WA, CA, EA, H, SA, NA, K
	NPH	821	14.16	***	NS	BAS, BAH, WA, CA, EA, H, SA, NA, K
	FRC	621	9.58	***	NS	BAS, BAH, WA, CA, EA, H, NA
	OCC	683	8.87	***	NS	BAS, BAH, WA, CA, EA, H, NA
	WFB	821	6.89	***	*	BAS, BAH, WA, CA, EA, H, SA, NA, K
	PAC	629	1.80	NS	NS	BAS, BAH, WA, CA, EA, H, NA
Females	BBH	561	27.74	***	NS	BAS, BAH, WA, CA, EA, NA, K
	XCB	520	23.36	***	*	BAS, BAH, WA, CA, EA, NA, K
	NLB	568	21.07	***	**	BAS, BAH, WA, CA, EA, NA, K
	OBB	484	19.47	***	NS	BAS, BAH, WA, CA, EA, NA, K
	ZYB	482	17.33	***	NS	BAS, BAH, WA, CA, EA, NA, K
	NPH	536	16.42	***	NS	BAS, BAH, WA, CA, EA, NA, K
	BPL	524	15.12	***	NS	BAS, BAH, WA, CA, EA, NA, K
	GOL	616	14.82	***	NS	BAS, BAH, WA, CA, EA, NA, K
	BNL	561	14.79	***	NS	BAS, BAH, WA, CA, EA, NA, K
	PAC	494	9.10	***	NS	BAS, BAH, WA, CA, EA, NA
	OCC	527	8.72	***	NS	BAS, BAH, WA, CA, EA, NA
	WFB	580	6.19	***	NS	BAS, BAH, WA, CA, EA, NA, K
	FRC	496	4.62	***	NS	BAS, BAH, WA, CA, EA, NA

[1] Level of significance: P < 0.05*, P < 0.01** or P < 0.001***.
[2] Levene's test of homogeneity of variance.
[3] Groups selected for analysis need a minimal number of individuals (N ⩾ 20): BAS = Basuku, BAH = Bahutu, WA = Western Africa, CA = Central Africa, EA = Eastern Africa, H = Horn of Eastern Africa, SA = Southern Africa, NA = Northern Africa, and K = Khoisan.

Table 3 — One-way analyses of variance for testing group differences on individual variables.

on the median, which better reflects the shape of a distribution (Schultz, 1985). Therefore it confirms that most of the variables are not skewed, except very slightly for a few ones (XCB, NLB, WFB).

5. Multivariate statistics

5.1. Factor analyses

In order to assess the complex morphological relationships amongst the various groups, several factor analyses (PCA) are performed. A rotation phase is achieved in order to obtain a simpler structure, or in other words, to transform complicated correlation matrices into easier ones to interpret (Annex 3). In particular, the varimax rotation is used, as it minimizes the number of variables having high loadings on a factor, increasing therefore the interpretability of the factors.

Three series of metric traits are selected here, as they represent different parts of the cranium (vault, face) both separately and in a combined manner. The variables are:

- for the vault, GOL, XCB, BBH, FRC, PAC, OCC;
- for the face, BNL, BPL, NPH, WFB, NLB, OBB;
- and for both the vault and face, GOL, XCB, ZYB, BBH, BPL, NPH, BNL, NLB.

Each type of analysis is run twice either with males or females. However, when analysing different parts of the cranium separately, the results were often nearly similar. Therefore the analyses with only the largest sample, which often corresponded to males, are presented here: for the vault, analysis I, and for the face, analysis II. When combining vault and face, analyses for both males (III) and females (IV) are retained, as they show different results.

In all analyses, at least two factors are obtained (table 4). As they present eigenvalues (or

Analysis n°, variables entered, & sample used	Factor 1 eigenvalue (%)	Factor 2 eigenvalue (%)	Cumulative % of variance	N° of factors extracted	Factor loadings after varimax rotation			% of variance[1]	
						factor 1	factor 2	factor 1	factor 2
Analysis I VAULT: GOL, XCB, BBH, FRC, PAC, OCC N = 581 (only males)	2.64 (44.01)	1.08 (17.95)	61.96	2	GOL	0.765	0.237	59	
					XCB	−0.070	0.708		50
					BBH	0.509	0.547		
					FRC	0.590	0.492		
					PAC	0.892	−0.100	80	
					OCC	−0.075	0.781		61
Analysis II FACE: BNL, BPL, NPH, WFB, NLB, OBB N = 574 (only males)	2.45 (40.82)	1.06 (17.65)	58.47	2	BNL	0.802	0.239	64	
					BPL	0.876	0.047	77	
					NPH	0.716	−0.062	51	
					WFB	0.118	0.803		64
					NLB	0.442	0.168		
					OBB	0.155	0.784		61
Analysis III VAULT & FACE: GOL, XCB, ZYB, BBH, BPL, NPH, BNL, NLB N = 632 (only males)	3.18 (39.74)	1.12 (14.04)	53.78	2	GOL	0.675	−0.055		
					XCB	0.642	−0.548		
					ZYB	0.677	0.155		
					BBH	0.632	−0.091		
					BPL	0.555	0.582		
					NPH	0.604	0.134		
					BNL	0.729	0.411	53	
					NLB	0.137	0.701		49
Analysis IV VAULT & FACE: GOL, XCB, ZYB, BBH, BPL, NPH, BNL, NLB N = 428 (only females)	3.38 (42.21)	1.24 (15.56)	57.77	2	GOL	0.745	−0.046	56	
					XCB	0.732	−0.378	54	
					ZYB	0.656	0.357		
					BBH	0.694	0.164		
					BPL	0.363	0.728		53
					NPH	0.531	0.355		
					BNL	0.728	0.442	53	
					NLB	−0.033	0.724		52

[1] The percentage of variance accounted on each factor is obtained by squaring the correlation coefficient (or factor loading) for the variables that have the highest factor loadings (> 0.7).

Table 4 — Summary of the four factor analyses (I–IV).

total variance explained by each factor) greater than one, they are retained for the varimax rotation. The total cumulative percentage of variance obtained for the various factor models is relatively high, as it varies between 54% and 62%.

For both males and females, the variables that are present most frequently on the factors with the highest loadings (⩾ 0.7), are:

- on factor 1, GOL (analyses I, IV) and BNL (analyses II, III);
- and on factor 2, NLB (analyses III, IV).

In summary, the following morphological features (or groups of inter-related variables) have been selected for the four factor analyses:

- for analysis I, vault length (factor 1), and vault breadth (factor 2);
- for analysis II, protrusion and height of face (factor 1), and breadths of face and orbits (factor 2);
- for analysis III, facial height (factor 1), and nasal breadth (factor 2);
- and for analysis IV, length, breadth and height of vault (factor 1), and both facial protrusion and nasal breadth (factor 2).

5.2. Univariate analyses on regression factor scores

In order to compare the degree of differentiation amongst the various groups under study, a test of equality of means (one-way analysis of variance) is also performed on the regression factor scores obtained through the different factor analyses. The results show that they are always significant at various levels of probability (table 5). F-values are the lowest when vault and face are analysed separately, but they tend to increase when both vault and face are combined.

In order to localize the group differences and similarities, post hoc multiple comparisons tests are also performed (Annex 4). When homogeneity of variance is significant through the Levene's test, Tamhane's test is used instead of the Scheffe's test.

In summary, the following two facts are observed:

- the Basuku are different from both the Bahutu and comparative sample, but in a variable manner depending on the variables considered; for example, similarities are high when vault and face are analysed separately, but differences occur much more often when the different parts of the cranium are combined together;
- and the Bahutu are often similar to Eastern Africa.

Independent sample t-tests are also achieved on the regression factor scores within pairs of groups. It allows us to test the degree of similarity and dissimilarity especially between each population under focus (Basuku or Bahutu) and each other group.

Concerning the Basuku (table 6), the latter are often very different from all other groups, as 46 tests (over 54 in total) are significant. Their similarity with one group in particular is very variable, as 8 tests are not significant always with different groups.

Analysis n°	Factor n°	N	F	Sig.[1]	L.[2]	Groups compared[3]
I	1		2.42	*	NS	7 groups: BAS, BAH, WA, CA, EA, H, NA
	2	566	22.83	***	*	
II	1		13.27	***	NS	8 groups: BAS, BAH, WA, CA, EA, SA, NA, K
	2	559	8.09	***	*	
III	1		22.78	***	NS	9 groups: BAS, BAH, WA, CA, EA, H, SA, NA, K
	2	627	14.54	***	NS	
IV	1		22.61	***	NS	7 groups: BAS, BAH, WA, CA, EA, NA, K
	2	408	26.24	***	NS	

[1] Level of significance: $P < 0.05$*, $P < 0.01$** or $P < 0.001$***.
[2] Levene's test of homogeneity of variance.
[3] Groups selected for analysis need a minimal number of individuals (N ⩾ 20): BAS = Basuku, BAH = Bahutu, WA = Western Africa, CA = Central Africa, EA = Eastern Africa, H = Horn of Eastern Africa, SA = Southern Africa, NA = Northern Africa, and K = Khoisan.

Table 5 — One-way analyses of variance: testing group differences on the regression factor scores.

Groups[1]	Analysis I				Analysis II				Analysis III				Analysis IV			
	Factor 1		Factor 2		Factor 1		Factor 2		Factor 1		Factor 2		Factor 1		Factor 2	
	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]
BAH	0.75	NS	0.97	NS	2.65	**	2.63	*	5.27	***	2.75	**	6.86	***	0.08	NS
WA	2.41	**	7.37	***	4.61	***	3.12	**	9.38	***	2.27	*	8.34	***	5.40	***
CA	2.36	*	5.03	***	0.88	NS	5.99	***	7.84	***	3.83	***	8.19	***	0.10	NS
EA	2.55	*	2.40	**	2.79	**	1.81	NS	5.91	***	3.56	***	6.25	***	0.51	NS
H	2.67	**	2.91	**	–	–	–	–	4.48	***	6.89	***	–	–	–	–
SA	–	–	–	–	6.81	***	1.34	NS	10.17	***	2.18	*	–	–	–	–
NA	2.70	**	6.36	***	1.02	NS	2.52	*	8.41	***	7.63	***	10.42	***	4.39	***
K	–	–	–	–	0.98	NS	0.83	NS	1.19	NS	5.15	***	5.09	***	6.54	***

[1] Groups selected for comparative analysis need a minimal number of individuals ($N \geqslant 20$): BAH = Bahutu, WA = Western Africa, CA = Central Africa, EA = Eastern Africa, H = Horn of Eastern Africa, SA = Southern Africa, NA = Northern Africa, and K = Khoisan.
[2] Level of significance: $P < 0.05$*, $P < 0.01$** or $P < 0.001$***.

Table 6 — Independent sample t-tests on regression factor scores: testing differences by pairs (between Basuku and each other group).

Groups[1]	Analysis I				Analysis II				Analysis III				Analysis IV			
	Factor 1		Factor 2		Factor 1		Factor 2		Factor 1		Factor 2		Factor 1		Factor 2	
	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]	t	Sig.[2]
BAS	0.75	NS	0.97	NS	2.65	**	2.63	*	5.27	***	2.75	**	6.86	***	0.08	NS
WA	1.18	NS	5.03	***	0.69	NS	0.43	NS	1.16	NS	1.44	NS	0.80	NS	3.90	***
CA	1.33	NS	3.52	***	1.99	*	1.68	NS	0.42	NS	0.04	NS	0.81	NS	0.00	NS
EA	1.31	NS	0.76	NS	0.35	NS	0.74	NS	0.61	NS	0.18	NS	2.62	*	0.34	NS
H	1.72	NS	1.78	NS	–	–	–	–	0.90	NS	3.36	**	–	–	–	–
SA	–	–	–	–	2.55	*	1.40	NS	3.08	**	1.23	NS	–	–	–	–
NA	2.10	*	4.96	***	1.46	NS	0.13	NS	2.30	*	4.02	***	2.46	*	3.61	***
K	–	–	–	–	2.92	**	3.35	***	4.11	***	1.85	NS	1.48	NS	5.43	***

[1] Groups selected for comparative analysis need a minimal number of individuals ($N \geqslant 20$): BAS = Basuku, WA = Western Africa, CA = Central Africa, EA = Eastern Africa, H = Horn of Eastern Africa, SA = Southern Africa, NA = Northern Africa, and K = Khoisan.
[2] Level of significance: $P < 0.05$*, $P < 0.01$** or $P < 0.001$***.

Table 7 — Independent sample t-tests on regression factor scores: testing differences by pairs (between Bahutu and each other group).

For the Bahutu (table 7), the similarities with other groups are more frequent than for the Basuku, as 31 tests (over 54 in total) are not significant. In particular, the Bahutu are also close to Eastern Africa, as only one test (over 8 in total) is significant.

5.3. Visualizing factor analyses

In order to show the group clustering, scatterplots for factors 1 and 2 of the four analyses are drawn (figs. 2–5). The morphological trends are observed more clearly in terms of variation and distance between the various groups. They are therefore discussed in relation to the three questions initially addressed, also taking into account the results of the various previous tests.

6. Discussion

Concerning the first question about the population affiliation of the two groups under focus, several comments can be done, as the different parts of the cranium provide different results.

As it was suggested by several tests (tables 5–7, Annex 4), when the vault and face are considered separately, they show more often the similarities than the differences between groups. For example, when analysing only the

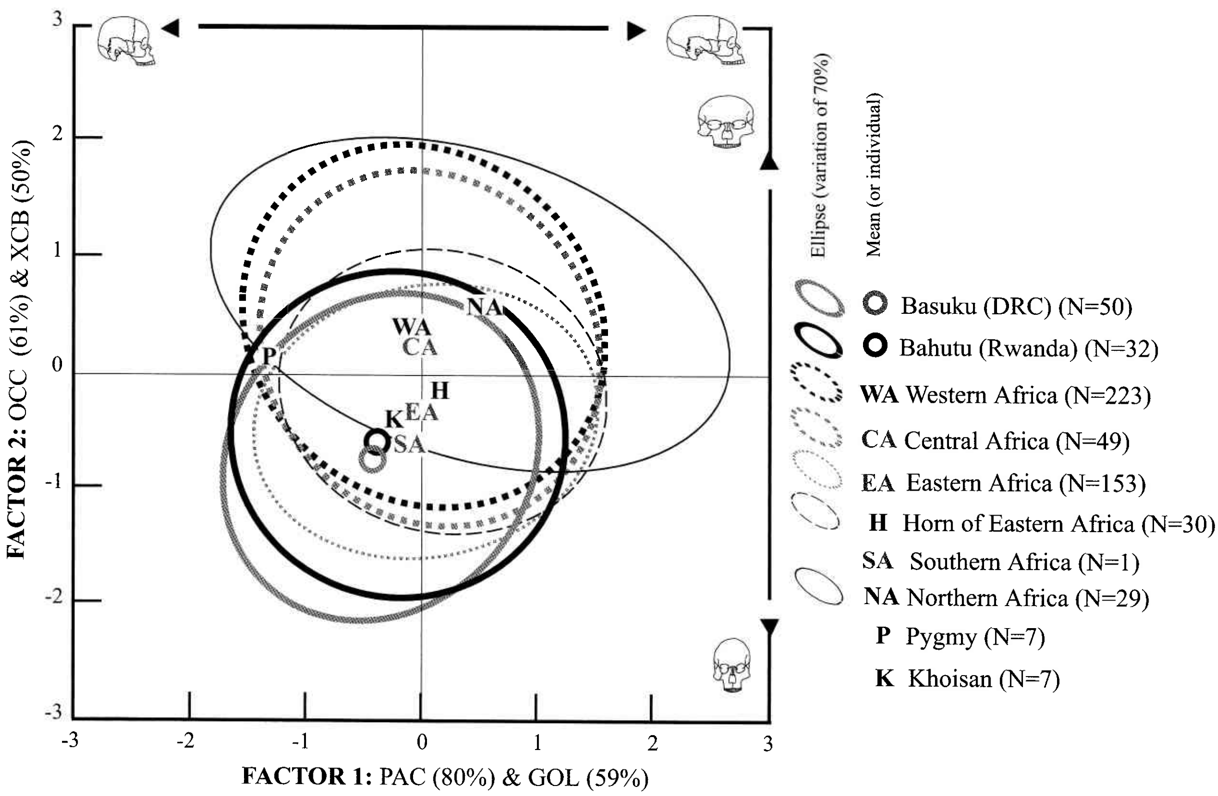

Fig. 2 — Scatterplot of first and second factors for analysis I using only vault variables (only males) expressing 62% of total variance.

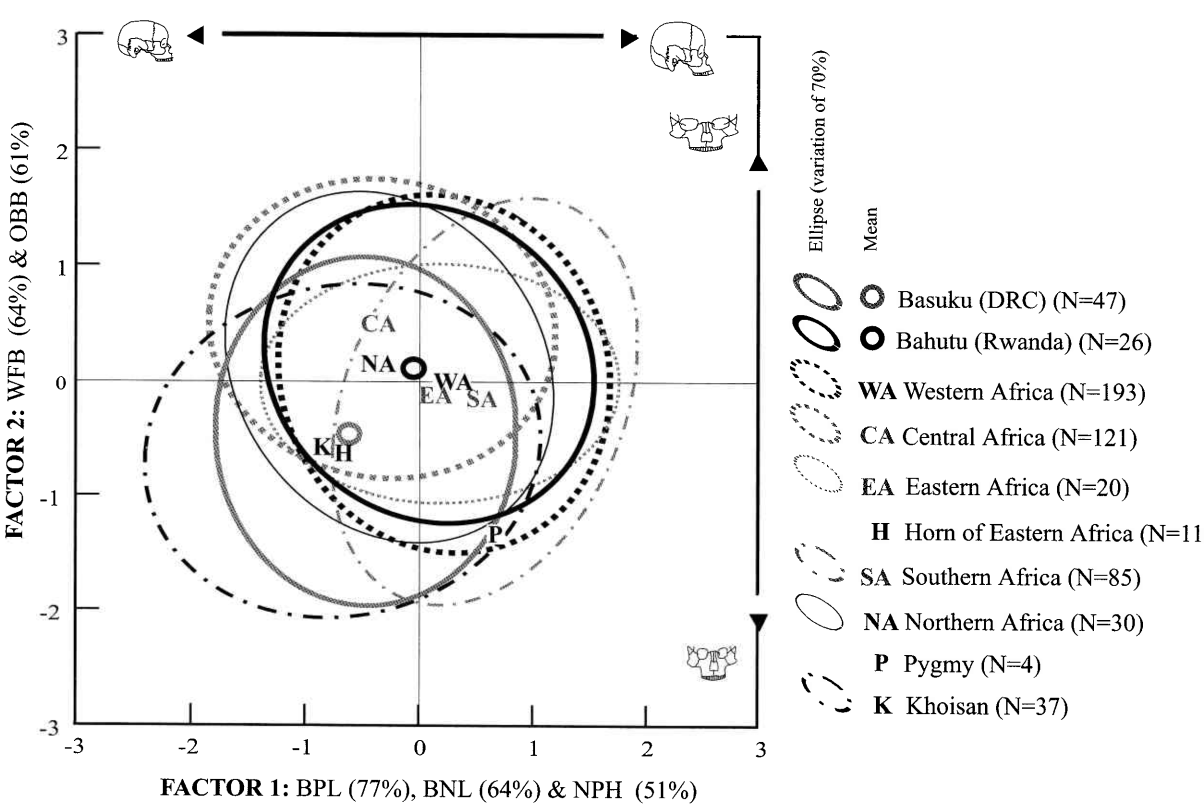

Fig. 3 — Scatterplot of first and second factors for analysis II using only facial variables (only males) expressing 60% of total variance.

vault (fig. 2), all the population means are clustered together except for the Pygmies and Northern Africa, the latter being the most distant from the Bahutu and Basuku. The Basuku are the closest to both the Bahutu and Eastern Africa. Length and breadth of vault taken on its own are therefore not very discriminatory, as the variation overlaps a lot despite significant mean differences.

When analysing only the face (fig. 3), the population means are less clustered, and the differences between the Basuku and the Bahutu increase. The Basuku are the closest to two groups (Khoisan, Horn of Eastern Africa) and the Bahutu to the remaining sample.

When both vault and face are combined (figs. 4 & 5), the Basuku are the closest to a small sample of Pygmies and the most distant from Northern Africa and Horn of Eastern Africa. In all factor analyses, the Bahutu are always the closest to Eastern Africa and Central Africa, as it is also suggested by previous t-tests.

Concerning the second question about differences and similarities between the two groups under focus, the following comment can be made: Basuku and Bahutu share relatively similar features such as length and breadth of vault, but they differ for the remaining features such as protrusion and height of face, size of orbits and nasal width. In particular, the Basuku have a less prognathic and lower face, narrower orbits and frontal as well as a wider nose than the Bahutu.

Concerning the last question about the possible biological effects of the Bantu-speakers expansion and the relationship of the two groups under focus with this historical event, several comments can be done. Because of the observed high levels of morphological diversity, the results can both agree and disagree with the presence of a homogenization process.

The facts that support the latter are the followings:

- Central Africa and Eastern Africa (both mainly Bantu-speaking) tend to cluster together, especially when face and vault are combined in the factor analyses (figs. 4 & 5);
- the eastern Bantu-speaking Bahutu are often close to their region of origin (Eastern Africa), according to all the factor analyses (figs. 2–5);
- and although the comparative African variation is very high in all factor analyses, extremes are often represented by Western Africa, Northern Africa and/or Khoisan, especially when face and vault are combined (figs. 4 & 5); most of the remaining groups, which correspond to Bantu-speakers (Bahutu, Central Africa, Eastern Africa), are located in-between these extremes.

However, there are also other observations that do not support the presence of a homogenization process within the Bantu-speakers, such as:

- Central Africa and Eastern Africa are not systematically similar to each other, especially in the factor analyses using vault and face separately (figs. 2 & 3);
- the west-central Bantu-speaking Basuku are relatively different from their region of origin (Central Africa); but they are not as different as Northern Africa is from Central Africa, especially when face and vault are combined in the factor analyses (figs. 4 & 5);
- and the African variation is very high in all factor analyses (figs. 2–5), as the various groups overlap each other quite a lot.

All these results reveal that it is difficult to interprete the high levels of craniometrical variation in relation to only one historical event such as the large-scale dispersal of Bantu-speakers. The effects of the latter are difficult to distinguish from other potential factors (geography, other historical events).

Geographical differentiation of populations within the entire African continent as well as sub-Saharan Africa is relatively high. Analyses of variance on the individual variables and the regression factor scores obtained from the various analyses showed that, the differentiation between the groups under focus and the comparative sample is always significant. Geography therefore seems to be a main key factor in shaping the morphological variation, as the natural barriers present between the regions can direct gene flow predominantly within an area. Within Africa, increasing or decreasing geographical proximity broadly seem to reflect inter-regional differences and/or similarities. For example, most marked differences are noted between the most distant groups (Western Africa and Khoisan), and the least marked ones between the closest groups (Eastern Africa and Central Africa).

However, the similarities between distant groups such as Western (and Central) Africa and Bantu-speaking Southern Africa suggest the impact of history in relation to the Bantu-speakers

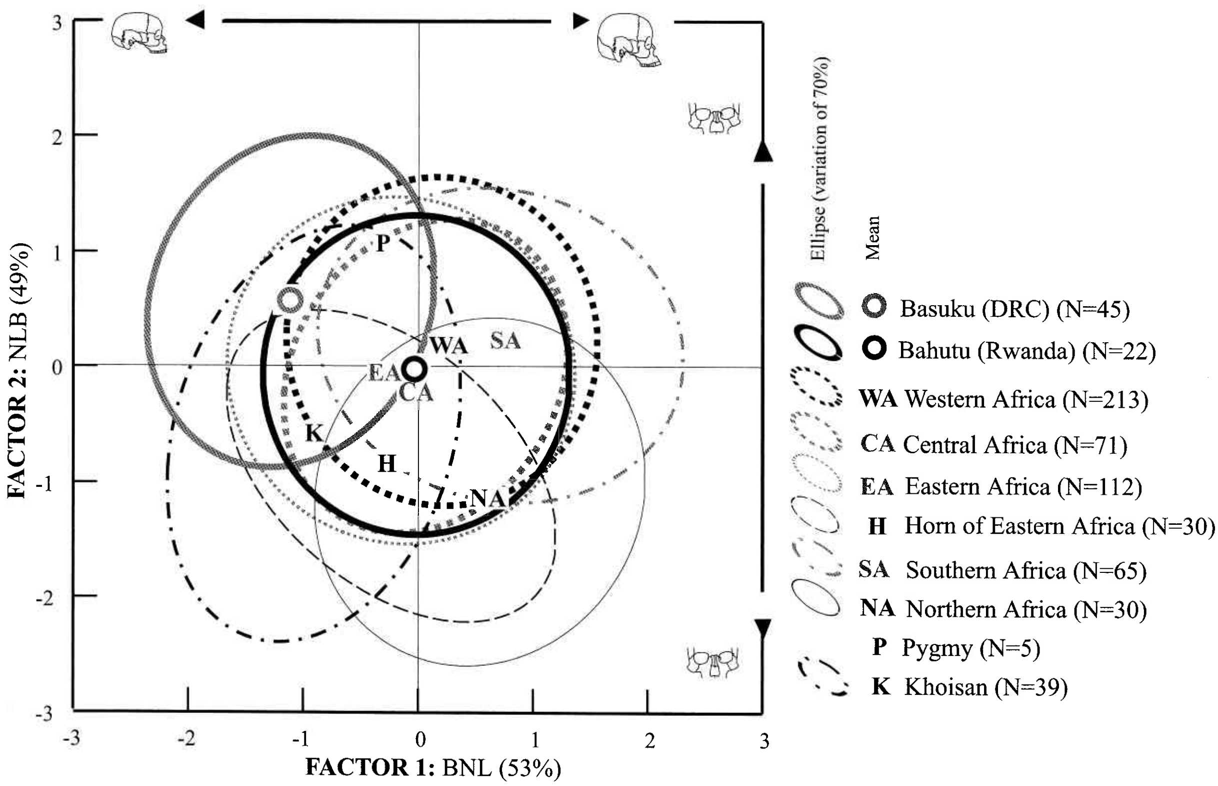

Fig. 4 — Scatterplot of first and second factors for analysis III using both vault and facial variables (only males) expressing 54% of total variance.

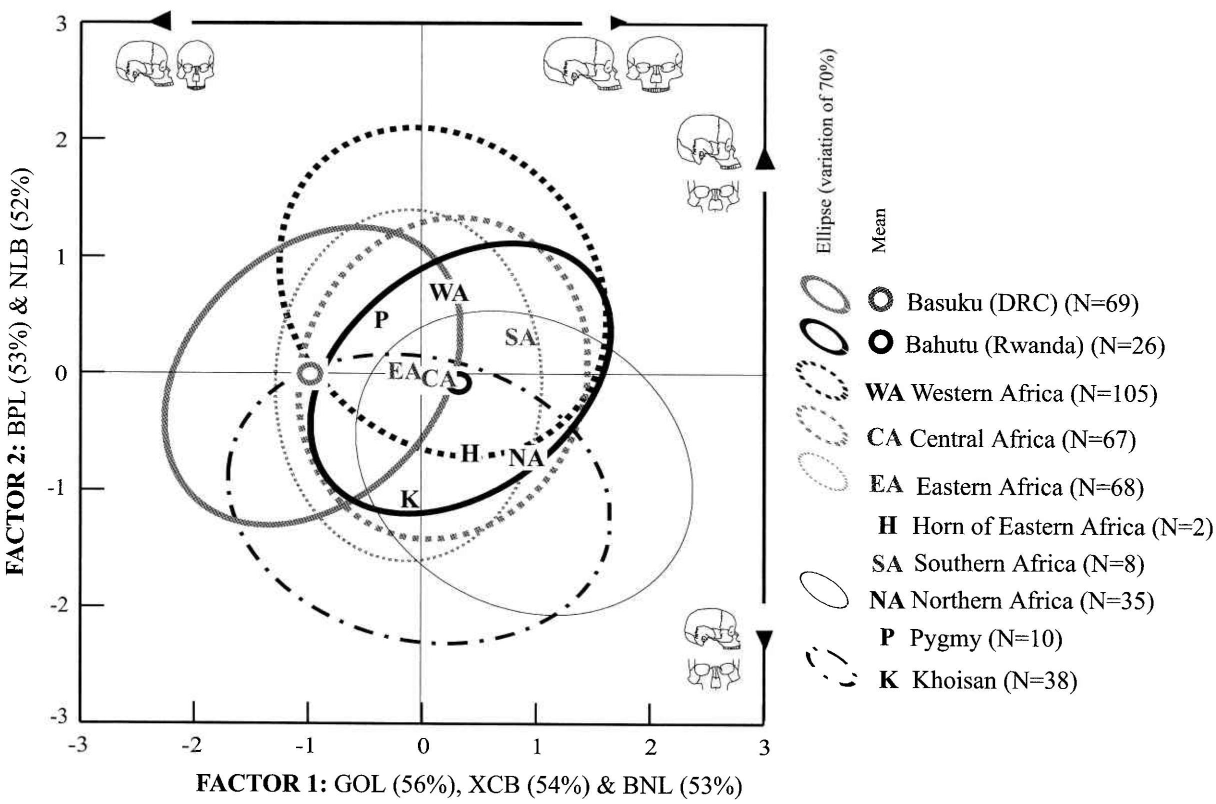

Fig. 5 — Scatterplot of first and second factors for analysis IV using both vault and facial variables (only females) expressing 58% of total variance.

expansion (figs. 3 & 4). Again, the position of the Basuku outside the cluster of Bantu-speaking populations (Central Africa, Eastern Africa, Bahutu) contradicts previous comments. In this case, it does not only reflect geographical distance and/or the effects of a large-scale expansion, but most probably several microevolutionary processes that could be superimposed on the previous ones (admixture, random processes).

In addition, as there is also a lot of overlapping variation between the different groups, the margins of error can therefore be very high when trying to identify morphological affinities of the two groups under focus. For example, although the Basuku and the Bahutu can be closer to the mean of a population in particular, they are very often located in a zone of overlapping variation. Concerning the vault only, their variation overlaps most of sub-Saharan Africa (fig. 2). Concerning the face only, this phenomenon is even greater (fig. 3). And, concerning the vault and face combined, around 50% of the Basuku variation still overlaps the other groups (figs. 4 & 5).

Therefore the results show that, similarities between the groups under focus (Basuku, Bahutu) and the Bantu-speaking populations are not always very clear and high enough to be considered as the result of only a homogenization process due to a large-scale expansion. This homogeneity, which is not systematically present within Bantu-speakers, is also suggested by other morphological and genetic studies (Hiernaux, 1976; Cavalli-Sforza *et al.*, 1994). Not only homogenization but also a regional diversification could have occurred in relation to both a dichotomous pattern of the Bantu-speakers expansion and various confounding factors reflecting geography and/or history.

In fact, this regional diversification increases even more, when ethnic groups are added to regional groupings. For example, in comparison to Eastern Africa (including the Bahutu), very high levels of variation have been observed within Central Africa (including the Basuku). This higher diversity could perhaps support linguistic data about a greater antiquity for the west-central stream, which evolved earlier than the eastern one (Heine, 1980; Ehret, 1997; Holden, 2001). As Heine (1980) and Holden (2001) observed that west-central Bantu languages are more diverse than the eastern group, the latter could therefore reflect a more recent evolution. The same authors therefore proposed an early west-central wave followed by a later eastern one. Nevertheless, these linguistic interpretations remain very hypothetical when applied to morphology, as the latter in evolutionary terms is not entirely comparable to languages.

Interpretations of the present work have also to remain very cautious on a different methodological level in relation to the nature and size of the sample under study. In fact, the present work was based on different units of study: it compared two relatively homogeneous cemetery populations belonging to different ethnic groups (Basuku, Bahutu) with a very heterogeneous sample of Africans, who originate from various regions. Therefore, the highly overlapping variation amongst all the groups might reflect the heterogeneous nature of the sample, which is based on different definitions of a 'population' (region, ethnic group, village). However, as, according to Hiernaux (1976), ethnic units are relatively more homogeneous (because of endogamy) than the broad regional groupings, they probably increased the overall geographical differences observed through the various analyses. Indirectly, this fact supports the work of Relethford (2001), who observed an underestimation of the diversity when analysing worldwide populations on a too broad regional level.

Of course, the subdivision of the comparative sample into separate regional areas and historic foraging groups is not completely accurate, as it does not take account of the population admixture in detail. For example, as the Khoisan group under study appear to be very variable, it probably corresponds to individuals, who have been admixed with non-Khoisan populations. Furthermore, the origin of a group or individual, which is reported in the museum archives, is possibly not always very accurate.

Nevertheless, although the subdivisions selected here for the modern groups are not ideal to use because of their relative inaccuracy, they probably reflect predominant gene flow within each region in relation to geography and/or history. These facts have been already supported by previous anthropometric work (Froment, 1998) as well as genetic data (Cavalli-Sforza *et al.*, 1994), and they therefore confirm the usefulness of the modern data as a comparative framework.

Unfortunately, only one of the historic foraging group such as the Khoisan is used for the interpretations, as the Pygmies are represented by a too small sample. Anyway, the latter do not differentiate much from other Bantu-speaking sub-Saharan Africans especially when the vault and face are combined (figs. 4 & 5), as it was also suggested by previous craniometrical research (Hiernaux, 1976; Froment, 1993, 1998).

The reliability of morphology for studies on population affinities can also be questioned here, as different parts of the cranium provide different results. In addition, when there is a similarity between two groups especially on the basis of one aspect only (vault or face), this fact does not mean genetical affinity necessarily. In order to assess fully the morphological variation, it is therefore necessary to use a high amount of craniometrical features preferentially in a combined manner. In particular, when facial variables are used with vault ones, the geographical differentiation is higher, and the number of modern groups overlapping each other variation decreases. In that case, the Basuku and the Bahutu appear more clearly localized within the African diversity, and interpretations were made more easily.

7. CONCLUSION

Having focused on the relationship of the Bahutu and Basuku with neighbouring African populations, interpretations about morphological differentiations in relation to geography and history have been attempted. Broad geographical differences have been observed, but they cannot explain fully the historical background, as morphology is very variable and affected by other confounding factors.

Nevertheless, this paper gave us the opportunity to focus on these unique collections of Basuku and Bahutu, which represent so far both the largest and the best documented cranial series of modern Central Africans and East Africans. It was necessary to assess morphologically the latter in relation to the present African diversity with an up-dated data set and a historical context that was not much explored so far.

Furthermore, the results underline the fact that, it is very difficult to build up a model for explaining the observed craniometrical variation. Geography, history and even climate might have been both long- and/or short-term processes, and it is not possible to discard them all, as they could be potential influences on morphology. Signatures of the Bantu-speakers dispersal (founder effect, diversification in two streams) have probably been obscured by all these factors. But, they are probably not completely destroyed, as the migratory event occurred on a very large scale. As it is suggested by previous studies (Hiernaux, 1976; Cavalli-Sforza *et al.*, 1994; Froment, 1998) and the present work, African diversity on an intra-regional level is higher than on an inter-regional level, and it still needs to be assessed morphologically in more detail.

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References

BANDELT H.-J., FORSTER P., SYKES B. C. & RICHARDS M. B., 1995. Mitochondrial portraits of human populations using median networks. *Genetics*, **141**: 743–753.

BASTIN Y., COUPEZ A. & DE HALLEUX B., 1983. Classification lexicostatistique des langues bantoues (214 relevés). *Bulletin des Séances de l'Académie Royale des Sciences d'Outremer*, **27** (2): 173–199.

BENINGTON R. C., 1912. A study of the negro skull with special reference to the Congo and Gaboon crania. *Biometrika*, **VIII**: 292–339.

BRABANT H., 1963. Observations anthropologiques et odontologiques sur les dents des Hutu du Rwanda. *Annales du Musée Royal de l'Afrique Centrale, Tervuren*, (Sciences Humaines) **47**, 30 p.

CAVALLI-SFORZA L., MENOZZI P. & PIAZZA A., 1994. *The history and geography of human* *genes*. New Jersey, Princeton University Press, 518 p.

CLARK J. D., 1980. Prehistoric populations and pressures favoring plant domestication in Africa. *In*: B.K. Savartz, J. Raymond & A. Dumett (éd.), *West African culture dynamics*. Bristol, Mouton Publishers: 67–105.

CLIST B., 1991. Synthèse régionale du Néolithique. *In*: R. Lanfranchi & B. Clist (éd.), *Aux origines de l'Afrique Centrale*. Libreville, Sépia édition: 180–189.

DAVID N., 1980. History of crops in North Cameroon to A.D. 1900. *In*: B.K. Swartz, J. Raymond & E. Dumett (éd.), *West African culture dynamics*. 9th International Congress of Anthropology and Ethnological Sciences (Chicago, 1973). The Hague, Mouton Publishers: 139–182.

DAVIES A., 1932. A re-survey of the morphology of the nose in relation to climate. *Journal of the Royal Anthropological Institute* (London), **62**: 337–359.

DE MARET P., 1977. Sanga: new excavations, more data and some related problems. *The Journal of African History*, **18**: 321–337.

DRONTSCHILOW K., 1913. Metrische studien an Schädeln aus Kamerun. *Archiv für Anthropologie*, **XL**: 161–183.

EHRET C., 1997. African languages: a historical survey. *In*: J.O. Vogel (éd.), *Encyclopedia of Precolonial Africa*. London, Altamira Press: 159–166.

ELLER E., 2001. Estimating relative population sizes from simulated data sets and the question of greater African effective size. *American Journal of Physical Anthropology*, **116**: 1–12.

FEREMBACH D., SCHWIDETZKI I. & STLOUKAL M., 1980. Recommendations for age and sex diagnoses of skeletons. *Journal of Human Evolution*, **9** (7): 517–549.

FROMENT A., 1992a. La différenciation morphologique de l'homme moderne : congruence entre forme du crâne et répartition géographique du peuplement. *Comptes Rendus de l'Académie des Sciences de Paris*, **315** (série III): 323–329.

FROMENT A., 1992b. Origines du peuplement de l'Égypte ancienne : l'apport de l'anthropobiologie. *Archéo-Nil*, **2**: 79–98.

FROMENT A., 1993. Adaptation biologique et variation dans l'espèce humaine : le cas des Pygmées d'Afrique. *Bulletins et Mémoires de la Société d'Anthropologie de Paris*, **5**: 417–448.

FROMENT A., 1998. Le peuplement de l'Afrique Centrale : contribution de la paléoanthropologie. *In*: M. Delneuf, J.M. Essomba & A. Froment (éd.), *Paléo-anthropologie en Afrique centrale : un bilan de l'Archéologie au Cameroun*. Paris, L'Harmattan: 13–90.

GILES B., DOYLE M., JOHNSTON M., WOOD I. & HARDING D., 1997. *Peoples of Central Africa*. New York, The Diagram Group, Facts on file Inc., 112 p.

GÓRNY S., 1957. Crania Africana. *Polska Akademia Nauk zaklad Anthropologii Materialy I prace Antropologiczne*, **14**, 37 p.

GREENBERG J.H., 1964. Historical inferences from linguistic research in sub-Saharan Africa. *Boston University Papers in African History*, **1**: 1–15.

HAMY E.T., 1882. Quelques observations sur l'anthropologie des Somalis. *Bulletins et Mémoires de la Société d'Anthropologie de Paris* (série III), **5**: 697–706.

HEINE B., 1980. Methods in comparative Bantu linguistics. The problem of Bantu linguistic classification. *In*: L.H. Hyman & J. Voorhoeve (éd.), *L'expansion bantoue*. Paris, SELAF: 295–320.

HIERNAUX J., 1972. Annexe I. Notes sur les restes osseux trouvés dans la tombe de Cyirima II. *In* : F.L. Van Noten (éd.), *Les tombes du roi Cyirima Rujugira et de la reine-mère Nyirayuhi Kanjogera. Description archéologique*. Annales du Musée Royal de l'Afrique Centrale, Tervuren (Sciences Humaines), **77**: 63–73.

HIERNAUX J., 1974. *The people of Africa*. London, Weidenfeld and Nicolson, Scribner's Sons, 217 p.

HIERNAUX J., 1976. Physical anthropology of the living populations of Sub-saharan Africa. *Annual Review of Anthropology*, **5**: 149–168.

HIERNAUX J. & FROMENT A., 1976. The correlation between anthropobiological and climate variables in sub-saharan Africa: revised estimates. *Human Biology*, **48**: 757–767.

HOLDEN C., 2001. Bantu language trees and cultural evolution. *Conference on Population history: genes, language and culture* (UCL, London, 16th June), abstract pre-print.

HOWELLS W.W., 1989. Skull shapes and the map: craniometric analyses in the dispersion of modern homo. *Papers of the Peabody Museum of Archaeology and Ethnology*, Peabody Museum, Harvard University, **79**, 189 p.

KITSON E., 1931. A study of the negro skull with special reference to the crania from Kenya colony. *Biometrika*, **23**: 271–314.

KNIP A., 1971. The frequencies of non-metrical variants in Tellem and Nokara skulls from the Mali Republic. I. & II. *Koninklijke Nederlandse Akademie van Wetenschappen (Proceedings of the Section of Sciences)*, series C, **74**: 422–443.

KROGMAN W.M. & ISCAN M.Y., 1986. *The human skeleton in forensic medicine*. Springfield (Illinois), C.C. Thomas: 268–301.

LAHR M.M., 1996. *The evolution of modern human diversity, a study of cranial variation*. Cambridge, Cambridge University Press, 416 p.

LESTER P., 1927. Contribution à l'anthropologie des Somalis. *Bulletins et Mémoires de la Société d'Anthropologie de Paris*, **8**: 175–187.

LESTER P., 1928. Étude anthropologique des populations de l'Éthiopie. *L'Anthropologie*, **38**: 289–315.

MARQUER P., 1972. Nouvelle contribution à l'étude du squelette des pygmées occidentaux du centre africain comparé à celui des pygmées orientaux. *Mémoires du Museum National d'Histoire Naturelle*, nouvelle série A (Zoologie), **LXXII**, 122 p.

MARTIN R. & SALLER K., 1959. *Lehrbuch der Anthropologie*. Stuttgart, Gustav Fischer Verlag, 1477 p.

MORRIS A.G., 1986. Khoi and San craniology: a re-evaluation of the osteological reference samples. *In*: R. Singer & J.K. Lundy (éd.), *Variation, culture and evolution in African populations: papers in honour of Dr. Hertha de Villiers*. Johannesburg, Witwatersrand University Press: 1–12.

MURDOCK G.P., 1959. *Africa, its peoples and their culture history*. London, McGraw-Hill Book Company, Inc., 456 p.

PEREIRA L., MACAULAY V., TORRONI A., SCOZZARI R., PRATA M.-J. & AMORIM A., 2001. Prehistoric and historic traces in the mtDNA of Mozambique: insights into the Bantu expansions and the slave trade. *Annals of Human Genetics*, **65**: 439–458.

PIETRUSEWSKY M., 2000. Metric analysis of skeletal remains: methods and applications. *In*: A. Katzenberg & S. Saunders (éd.), *Biological Anthropology of the human skeleton*. New York, A John Wiley & Sons Inc., Publication: 375–415.

POUTRIN D., 1910. Contribution à l'étude des pygmées d'Afrique : les négrilles du Centre Africain. *L'Anthropologie*, **XXI**: 435–504.

REINECKE P., 1896. Beschreibung einiger Rassenskelette aus Afrika. *Archiv für Anthropologie*, **XXV**: 185–227.

RELETHFORD J.H., 2001. Global analysis of regional differences in craniometric diversity and population substructure. *Human Biology*, **73** (5): 629–636.

RELETHFORD J.H. & HARPENDING H.C., 1994. Craniometric variation, genetic theory, and modern human origins. *American Journal of Physical Anthropology*, **95**: 249–270.

RIBOT I., 2002. *Craniomandibular variation in sub-Saharan Africa: sexual dimorphism, geography, ecology and history*. PhD dissertation. Cambridge, University of Cambridge, 392 p.

RIGHTMIRE G.P., 1972. Cranial measurements and discrete traits compared in distance studies of African negro skulls. *Human Biology*, **44** (3): 263–276.

SALMONS J.E., 1925. The Bush and the Bantu mandibles. *The South African Journal of Science*, **22**: 470–479.

SCHULTZ B.B., 1985. Levene's test for relative variation. *Systematic Zoology*, **34** (4): 449–456.

SERGI S., 1912. *Crania Habessinica : contributo all'antropologia dell'Africa orientale*. Berlin, Virchov-Stiftung publication, 519 p.

SHRUBSALL F., 1897. Crania of African Bush races. *Journal of the Royal Anthropological Institute (of Great Britain and Ireland)*, **27**: 263–290.

SHRUBSALL F., 1898. A study of A-Bantu skulls and crania. *Journal of the Royal Anthropological Institute (of Great Britain and Ireland)*, **28**: 55–94.

SHRUBSALL F., 1907. Notes on some Bushman crania and bones from the South African Museum, Cape Town. *Annals of the South African Museum (Cape Town)*, **V** (5): 227–270.

THOMSON A. & BUXTON L. H. D., 1923. Man's nasal index in relation to certain climatic conditions. *Journal of the Royal Anthropological Institute*, **53**: 92–122.

UNDERHILL P. A., PASSARINO G., LIN A. A., SHEN P., LAHR M. M., FOLEY R. A., OEFNER P. J. & CAVALLI-SFORZA L. L., 2001. The phyleogeography of Y chromosome binary haplotypes and the origins of modern human populations. *Annals of Human Genetics*, **65**: 43–62.

VAN BAKEL M. A., 1981. The "Bantu" expansion: demographic models. *Current Anthropology*, **22** (6): 688–691.

VAN DE GINSTE F., 1946. Anthropometric study of the Bapende and Basuku of the Belgian Congo. *American Journal of Physical Anthropology*, **4** (2): 125–152.

VANSINA J., 1995. New linguistic evidence and the Bantu expansion. *Journal of African History*, **36**: 173–195.

WEINER J. S., 1954. Nose shape and climate. *American Journal of Physical Anthropology*, **12**: 615–618.

WINDENMANN D., 1896. Untersuchung von 30 Dschaggaschädeln. *Archiv für Anthropologie*, **XXV**: 361–396.

YAKAN M. Z., 1999. *Almanac of African peoples and nations*. New Brunswick, Transaction Publishers, 755 p.

ZAR J. H., 1984. Biostatistical analysis. New Jersey, Prentice-Hall, Englewood Cliffs, 718 p.

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ANNEX 1

Detailed list of the cranial series under study

Groups under study	Sources for metric data	Country	Region or city	Language[1]	Ethnic origin (or references)	Place of deposit[2]	Total sample
BASUKU	Ribot, 2002	DRC	Feshi	NK nc bc	(Van de Ginste, 1946)	IRScNB	144
BAHUTU	Ribot, 2002	Rwanda	Kisenyi, Bugoye	NK nc bc	(archives: Van Saceghem)	IRScNB	15
	Ribot, 2002	Rwanda	Ruhengeri	NK nc bc	(archives: Nenquin)	IRScNB	74
WESTERN AFRICA	Reinecke, 1896	Cameroon	Yaounde	NK nc bc	–	AMNH	1
	Drontschilow, 1913	Cameroon	Grasslands	NK nc bc	> 15 groups	VM	86
	Ribot, 2002	Cameroon	various	NK nc bc	Bamum, Boki	AMNH	40
	Drontschilow, 1913	Nigeria	south-east	NK nc	Ekoi	VM	1
	Ribot, 2002	Nigeria	Onatshi?	NK nc kw	Ibo	NHM	33
	Ribot, 2002	Nigeria	Hausa region	AA cha	Haoussa	IRScNB	1
	Ribot, 2002	Nigeria	Calabar, Atakpa	NK nc kw	various	AMNH	24
	Ribot, 2002	Nigeria	Ibadan?	NK nc kw	Yoruba	AMNH	1
	Ribot, 2002	Benin	Abome, Whydah	NK nc kw	various	AMNH	13
	Ribot, 2002	Togo	–	NK nc kw	Yendi, Ewe	AMNH	9
	Ribot, 2002	Ghana	Gold Coast	NK nc kw	various	AMNH	59
	Ribot, 2002	Liberia	Vai, Monrovia	(NK nc kw)	–	AMNH	3
	Knip, 1971	Mali	Nokara	–	Kurumba?	Grav	62
	Ribot, 2002	Mali	Nokara	–	Kurumba?	Grav	22
	Ribot, 2002	Senegal	various	NK nc wa	Kere, Moussa	FA	23
	Ribot, 2002	Senegal	Diola	NK nc ma	Diola	IFAN	6
	Ribot, 2002	Senegal	Serer (centre)	NK nc wa	griots Serer	IFAN	14
	Ribot, 2002	Senegal	Lebu (Dakar)	NK nc wa	griots Lebu	IFAN	28
CENTRAL AFRICA	Poutrin, 1910	Gabon	various	NK nc bc	Kama	MHN	12
	Benington, 1912	Gabon	N'Komi	NK nc bc	N'Komi	NHM	129
	Shrubsall, 1898	DRC	Low Congo	NK nc bc	–	AM	3
	Benington, 1912	DRC	Makunji	NK nc bc	Batetela	destroyed	76
	Ribot, 2002	DRC	various	NK nc bc	Basundi, Warua	IRScNB	31
	Shrubsall, 1898	Congo	Ubangui	NK nc bc	–	AM	2
	Ribot, 2002	Congo	Alima N'Gunda	NK nc bc	Tegue	IRScNB	2
	Ribot, 2002	Angola	Loango	NK nc bc	–	IRScNB	1

[1] Linguistic affiliation categories: AA = Afro-Asiatic including Semitic (sem), Cushitic (cu) and Chadic (cha); NK = Niger-Kordofanian including Niger-Congo (nc) that also includes West Atlantic (wa), Mande (ma), Kwa (kw) and Benue-Congo or Bantu (bc); and K = Khoisan.

[2] Place of deposit: AM = Anatomy Museum, Cambridge; AMNH = American Museum of Natural History, New York; BD = Baranard Davis' Collection, UK; BM = British Museum, London; Duckw = Duckworth Laboratory, Cambridge; FA = Faculty of Anatomy, Dakar; Grav = Gravenzande Collection, Leiden; IFAN = IFAN Cheikh Anta Diop Institute, Dakar; IPH = Institut de Paléontologie Humaine, Paris; IRScNB = Institut Royal des Sciences Naturelles de Belgique, Brussels; MH = Musée de l'Homme, Paris; NHM = Natural History Museum, London; MHN = Museum d'Histoire Naturelle, Paris; MM = Munich Museum; NH = Netley Hospital, Army Medical Museum, UK; RCS = Royal College of Surgeons, London; ULB = Université Libre de Bruxelles (Laboratoire d'Anthropologie et de Génétique Humaine); V = Vesaliannum, Basle; VM = Volkenkunde Museum, Berlin; W = Wrocław University, Poland.

(FOLLOWING OF ANNEX 1)

Groups under study	Sources for metric data	Country	Region or city	Language[1]	Ethnic origin (or references)	Place of deposit[2]	Total sample
EASTERN AFRICA	Hiernaux, 1972	Rwanda	Gaseke	NK nc bc	Tutsi (king)	?	1
	Ribot, 2002	Rwanda	Kivu, Kibuye	NK nc bc	Tutsi	IRScNB	1
	Ribot, 2002	Rwanda	Kivu, Ngweshe	NK nc bc	–	IRScNB	2
	Ribot, 2002	Burundi	Bujumbura	NK nc bc	Murundi?	IRScNB	1
	Górny, 1957	Uganda	hospitals?	(NK nc bc)	–	W	175
	Reinecke, 1896	Kenya	various	NK nc bc	Pare, Shambaa	MM	6
	Widenmann, 1896	Kenya	Kilimandjaro	NK nc bc	Dschagga	VM	30
	Kitson, 1931	Kenya	Dabida	NK nc bc	Teita	Duckw	1
	Ribot, 2002	Kenya	Dabida	NK nc bc	Teita	Duckw	137
	Ribot, 2002	Tanzania	Musira island	NK nc bc	Haya	Duckw	34
HORN OF EASTERN AFRICA	Hamy, 1882	Somalia	Medjeurtin	AA cu	Somali	MHN	2
	Sergi, 1912	Somalia	–	AA cu	Somali	VM	5
	Lester, 1927	Somalia	various	AA cu	Somali(-Abgal)	MHN	5
	Ribot, 2002	Somalia	(Diredawa)	AA cu	Somali, Beja	Duckw	23
	Sergi, 1912	Ethiopia	Goba	AA cu	Galla	VM	5
	Lester, 1928	Ethiopia	various	AA cu	Galla (Arusi, Itu)	MHN	18
SOUTHERN AFRICA	Shrubsall, 1898	Mozambique	various	NK nc bc	Wahenga, Urega	BM	23
	Shrubsall, 1898	South Africa	Natal	NK nc bc	Xhosa	BD	40
	Shrubsall, 1898	South Africa	Natal	NK nc bc	Zulu	NHM	24
	Shrubsall, 1898	South Africa	Cape	NK nc bc	Angoni	BM	25
NORTHERN AFRICA	Storto (pers. com.)	Algeria	various	AA sem	–	MH	29
	Storto (pers. com.)	Tenerife	various	AA sem	–	MH	9
	Storto (pers. com.)	Morocco	various	AA sem	–	MH	15
	Storto (pers. com.)	Tunisia	various	AA sem	–	MH	12
PYGMY	Poutrin, 1910	Gabon	High Ngounie	NK nc bc	Akoa, O'Bongo	MHN	3
	Marquer, 1972	Gabon	(inland)	NK nc bc	Babongo	MHN	3
	Marquer, 1972	Congo	(central region)	NK nc bc	Babinga	MHN	9
	Marquer, 1972	Cameroon	south-east	NK nc bc	–	MHN	1
	Ribot, 2002	DRC	Ituri	NK nc bc	Efe	MHN	3
	Ribot, 2002	DRC	–	NK nc bc	Twa?	IRScNB	2
KHOISAN	Shrubsall, 1897	South Africa	various	K	San, Khoikhoi?	various	62
	Shrubsall, 1907	South Africa	various	K	San, Khoikhoi?	?	24
	Salmons, 1925	South Africa	various	K	San, Khoikhoi?	?	2
	Ribot, 2002	South Africa	Knysna, Cape	K	San, Khoikhoi?	Duckw	4
	Ribot, 2002	South Africa	various	K	San, Khoikhoi?	AMNH	11
	Shrubsall, 1897	Botswana?	Kalahari	K	San, Khoikhoi?	BM	2
	Ribot, 2002	Botswana?	Kalahari	K	San, Khoikhoi?	NHM	5
						Total	1659

ANNEX 2

Summary of descriptive data (in mm) with independent sample t-tests for male and female comparisons within the ten groups and total sample.

	Basuku					
	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]
GOL	M=53 F=82	128.70 170.57	5.11 5.72	7.59	7.8	***
XCB	M=53 F=84	128.70 125.44	5.11 4.95	3.26	3.71	***
BBH	M=52 F=81	130.87 124.74	5.21 5.40	6.13	6.47	***
FRC	M=56 F=85	108.40 104.61	4.95 6.07	3.79	3.90	***
PAC	M=51 F=84	111.64 107.91	6.71 6.84	3.73	3.09	**
OCC	M=51 F=82	93.47 91.51	6.40 5.45	1.96	1.88	NS
BNL	M=52 F=79	97.04 92.09	3.30 4.62	4.96	7.17	***
BPL	M=47 F=77	99.61 93.81	5.58 5.64	5.80	5.56	***
NPH	M=50 F=77	63.36 59.25	5.18 4.46	4.11	4.76	***
WFB	M=57 F=86	94.49 89.91	4.56 4.38	4.58	6.02	***
NLB	M=53 F=78	27.64 26.26	2.28 1.76	1.39	3.92	***
OBB	M=54 F=78	39.07 37.28	1.66 1.79	1.79	5.81	***
ZYB	M=49 F=73	126.31 117.28	4.87 5.82	9.03	8.95	***

	Bahutu					
	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]
GOL	M=41 F=46	184.72 178.53	5.71 6.75	6.19	4.59	***
XCB	M=41 F=46	134.84 130.24	4.21 4.23	4.60	5.08	***
BBH	M=33 F=41	126.36 123.10	6.07 4.70	3.26	2.60	*
FRC	M=38 F=48	107.55 104.74	4.50 4.33	2.81	2.94	**
PAC	M=40 F=47	112.23 107.17	6.57 6.32	5.06	3.66	***
OCC	M=39 F=44	92.73 91.88	5.88 4.36	0.86	0.75	NS
BNL	M=34 F=42	93.90 96.71	4.88 4.93	2.18	1.93	NS
BPL	M=27 F=38	101.83 97.89	6.21 5.48	3.94	2.70	**
NPH	M=32 F=39	68.88 65.67	4.79 4.47	3.21	2.91	**
WFB	M=39 F=47	97.33 94.33	5.04 5.40	3.00	2.65	*
NLB	M=34 F=41	27.22 25.09	1.65 2.00	2.13	4.97	***
OBB	M=31 F=41	40.26 38.84	1.74 1.81	1.43	3.36	**
ZYB	M=25 F=28	132.44 124.25	6.39 4.81	8.19	5.22	***

	Western Africa					
	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]
GOL	M=243 F=132	181.04 174.17	6.08 6.49	6.88	10.21	***
XCB	M=242 F=131	135.62 129.60	5.90 6.19	6.02	9.25	***
BBH	M=232 F=125	135.36 129.80	5.20 5.57	5.56	9.40	***
FRC	M=238 F=134	111.47 106.68	5.08 5.17	4.79	8.68	***
PAC	M=239 F=132	114.05 110.91	6.81 5.16	3.14	4.99	***
OCC	M=231 F=128	97.25 92.46	5.63 5.24	4.79	7.91	***
BNL	M=236 F=126	100.83 96.89	4.46 3.89	3.94	8.37	***
BPL	M=225 F=115	102.33 98.84	5.65 4.96	3.49	5.61	***
NPH	M=230 F=120	67.92 64.65	4.93 4.36	3.27	6.12	***
WFB	M=206 F=112	95.98 92.00	5.09 5.37	3.98	6.53	***
NLB	M=238 F=127	28.10 27.40	2.16 2.01	0.70	3.02	**
OBB	M=225 F=118	40.47 39.26	1.95 1.78	1.21	5.62	***
ZYB	M=234 F=118	132.31 123.98	5.44 5.75	8.33	13.30	***

	Central Africa					
	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]
GOL	M=143 F=111	179.52 171.43	6.46 6.23	8.09	10.05	***
XCB	M=142 F=111	136.44 130.80	4.88 5.24	5.64	8.83	***
BBH	M=92 F=83	134.91 130.16	5.42 5.55	4.75	5.72	***
FRC	M=51 F=47	112.02 106.85	4.89 4.98	5.17	5.18	***
PAC	M=51 F=47	113.62 106.98	6.40 5.18	6.64	5.61	***
OCC	M=129 F=106	95.67 94.59	5.26 5.60	1.08	1.52	NS
BNL	M=137 F=106	99.97 95.38	4.44 4.09	4.59	8.26	***
BPL	M=127 F=99	99.64 96.99	6.02 5.55	2.65	3.40	***
NPH	M=137 F=100	65.94 61.98	5.52 5.18	3.96	5.60	***
WFB	M=142 F=106	97.02 92.74	3.89 4.12	4.28	8.36	***
NLB	M=142 F=103	26.54 25.16	2.10 1.80	1.37	5.36	***
OBB	M=139 F=106	41.06 39.70	1.74 1.98	1.36	5.71	***
ZYB	M=118 F=93	129.36 121.54	5.97 4.64	7.82	10.40	***

[1] Number of individuals for both males (M) and females (F).
[2] Level of significance: $P < 0.05$*, $P < 0.01$** or $P < 0.001$***.

(FOLLOWING OF ANNEX 2)

	Eastern Africa						Horn of Eastern Africa						Southern Africa						Northern Africa					
	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]
GOL	M=199 F=163	183.98 175.28	6.35 5.53	8.70	13.73	***	M=49 F=8	181.22 174.50	5.88 7.21	–	–	–	M=102 F=10	186.27 176.55	6.85 6.69	–	–	–	M=30 F=35	185.17 176.80	7.52 5.49	8.37	5.17	***
XCB	M=198 F=166	132.53 127.55	5.07 4.62	4.99	9.73	***	M=48 F=8	133.33 128.94	5.49 3.99	–	–	–	M=99 F=10	135.60 132.20	5.87 5.05	–	–	–	M=30 F=35	138.47 133.60	4.71 4.58	4.87	4.22	***
BBH	M=176 F=151	129.26 123.80	5.36 5.44	5.46	9.12	***	M=46 F=5	133.24 128.20	5.08 6.94	–	–	–	M=100 F=9	136.51 134.39	5.54 10.25	–	–	–	M=30 F=35	135.03 130.26	6.91 5.13	4.78	3.19	**
FRC	M=178 F=147	110.13 105.46	4.56 4.72	4.67	9.03	***	M=31 F=2	111.55 109.50	5.64 7.78	–	–	–	M=1 F=1	118.00 93.00	– –	–	–	–	M=29 F=35	114.48 108.49	5.55 4.18	6.00	4.93	***
PAC	M=187 F=149	112.87 108.14	6.63 5.51	4.73	6.99	***	M=31 F=2	114.46 113.00	4.92 12.73	–	–	–	M=1 F=0	108.00 –	– –	–	–	–	M=30 F=35	115.00 112.51	7.92 5.00	2.49	1.53	NS
OCC	M=173 F=132	94.20 90.32	4.73 4.57	3.88	7.19	***	M=30 F=2	95.02 97.50	4.55 0.71	–	–	–	M=1 F=0	96.00 –	– –	–	–	–	M=30 F=35	96.27 92.94	5.55 5.06	3.32	2.53	*
BNL	M=161 F=129	99.45 94.64	4.56 4.72	4.81	8.79	***	M=36 F=4	99.11 94.50	3.48 2.08	–	–	–	M=101 F=9	103.10 98.78	4.58 5.95	–	–	–	M=30 F=35	102.10 98.06	5.87 4.15	4.04	3.24	**
BPL	M=148 F=117	101.20 94.64	5.78 5.50	6.56	9.37	***	M=31 F=3	95.42 91.80	4.07 5.91	–	–	–	M=91 F=9	104.12 100.00	5.24 4.74	–	–	–	M=30 F=35	98.83 94.89	5.29 4.65	3.95	3.20	**
NPH	M=156 F=122	68.58 63.51	4.69 4.82	5.08	8.84	***	M=41 F=4	68.38 63.66	4.25 4.64	–	–	–	M=94 F=10	69.00 62.80	4.61 5.79	–	–	–	M=30 F=35	67.00 64.66	3.73 4.89	2.34	2.14	*
WFB	M=175 F=164	96.14 91.78	4.91 4,29	4.35	8.70	***	M=28 F=7	93.04 89.43	4.88 3.46	–	–	–	M=100 F=9	98.64 92.56	5.13 3.75	–	–	–	M=30 F=35	96.43 92.94	4.71 4.13	3.49	3.18	**
NLB	M=178 F=140	26.73 25.70	2.22 2.63	1.03	3.78	***	M=39 F=5	24.85 23.66	1.84 2.32	–	–	–	M=100 F=10	27.25 27.00	2.16 1.49	–	–	–	M=30 F=35	24.57 23.80	2.03 1.75	0.77	1.64	NS
OBB	M=84 F=63	40.02 38.26	1.94 1.60	1.76	5.85	***	M=42 F=5	39.38 38.43	1.90 2.42	–	–	–	M=96 F=9	38.69 37.89	1.94 2.32	–	–	–	M=30 F=35	40.33 38.86	1.56 1.87	1.48	3.43	***
ZYB	M=128 F=96	129.65 121.68	5.07 4.71	7.97	12.01	***	M=35 F=3	125.81 119.83	4.90 5.11	–	–	–	M=74 F=9	131.57 124.44	6.08 6.09	–	–	–	M=30 F=35	131.33 123.20	4.60 5.68	8.13	6.28	***

(FOLLOWING OF ANNEX 2)

	Pygmy						Khoisan						Total sample					
	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]	N[1]	Mean	S.D.	Mean diff.	t	Sig.[2]
GOL	M=9 F=12	175.39 169.58	5.26 5.93	–	–	–	M=63 F=47	180.83 175.53	6.01 6.77	5.29	4.33	***	M=932 F=646	182.08 174.03	6.69 6.51	8.05	23.75	***
XCB	M=9 F=12	134.83 129.25	5.52 5.10	–	–	–	M=62 F=47	134.65 134.12	5.00 5.83	0.53	0.51	NS	M=924 F=650	134.55 129.36	5.72 5.71	5.20	17.77	***
BBH	M=9 F=11	130.00 125.46	7.52 3.67	–	–	–	M=59 F=45	127.90 124.87	5.04 5.61	3.03	2.89	**	M=829 F=586	132.79 126.76	6.29 6.26	6.03	17.81	***
FRC	M=7 F=11	107.04 104.00	4.05 4.13	–	–	–	M=7 F=15	112.50 111.64	5.38 4.97	–	–	–	M=829 F=525	132.79 106.03	6.29 5.24	4.72	15.43	***
PAC	M=7 F=11	105.71 103.56	7.21 4.45	–	–	–	M=7 F=15	110.43 108.62	6.80 6.22	–	–	–	M=636 F=522	110.75 108.84	5.13 5.96	4.45	11.95	***
OCC	M=7 F=11	96.43 90.15	2.94 4.27	–	–	–	M=7 F=14	93.10 91.71	5.54 6.84	–	–	–	M=644 F=554	113.29 92.15	6.75 5.32	3.32	10.75	***
BNL	M=9 F=11	99.67 94.41	4.51 4.19	–	–	–	M=58 F=44	96.18 93.18	5.07 4.93	3.00	3.00	**	M=854 F=585	100.04 95.22	4.82 4.74	4.82	18.75	***
BPL	M=6 F=10	107.06 98.57	4.56 4.13	–	–	–	M=51 F=43	96.54 91.73	7.03 5.00	4.81	3.86	***	M=783 F=546	100.95 95.99	6.13 5.73	4.97	15.11	***
NPH	M=7 F=12	65.99 60.73	3.86 4.63	–	–	–	M=51 F=43	62.95 60.58	5.32 4.34	2.36	2.37	***	M=828 F=562	67.27 62.82	5.22 5.07	4.44	15.77	***
WFB	M=8 F=11	94.69 91.37	6.59 3.39	–	–	–	M=44 F=30	94.90 93.21	4.54 3.72	1.69	1.69	NS	M=829 F=607	96.32 92.04	4.93 4.63	4.28	16.68	***
NLB	M=9 F=12	27.79 26.65	2.52 2.14	–	–	–	M=54 F=44	26.22 25.27	2.38 1.95	0.95	2.16	*	M=877 F=595	27.02 25.88	2.34 2.31	1.14	9.27	***
OBB	M=9 F=12	39.42 37.57	1.83 1.97	–	–	–	M=55 F=43	38.30 37.28	1.72 2.15	1.02	2.61	*	M=765 F=510	39.97 38.63	2.04 2.06	1.34	11.43	***
ZYB	M=9 F=12	131.72 120.75	5.32 3.79	–	–	–	M=45 F=39	123.87 117.72	5.43 5.50	6.15	5.14	***	M=747 F=506	130.07 121.51	6.00 5.76	8.55	25.17	***

ANNEX 3

Correlation matrices for the four factor analyses (at least $P < 0.05$)

Analysis I

	GOL	XCB	BBH	FRC	PAC	OCC
GOL	**1.00**	0.26	0.25	0.51	0.54	0.31
XCB	0.26	**1.00**	0.26	0.31	0.09	0.28
BBH	0.25	0.26	**1.00**	0.53	0.42	0.42
FRC	0.51	0.31	0.53	**1.00**	0.30	0.26
PAC	0.54	0.09	0.42	0.30	**1.00**	0.06
OCC	0.31	0.28	0.42	0.26	0.06	**1.00**

Analysis II

	BNL	BPL	NPH	WFB	NLB	OBB
BNL	**1.00**	0.67	0.43	0.29	0.22	0.27
BPL	0.67	**1.00**	0.45	0.17	0.31	0.17
NPH	0.43	0.45	**1.00**	0.15	0.17	0.20
WFB	0.29	0.17	0.15	**1.00**	0.12	0.31
NLB	0.22	0.31	0.17	0.12	**1.00**	0.18
OBB	0.27	0.17	0.20	0.31	0.18	**1.00**

Analysis III

	GOL	XCB	ZYB	BBH	BPL	NPH	BNL	NLB
GOL	**1.00**	0.28	0.28	0.30	0.34	0.34	0.53	0.11
XCB	0.28	**1.00**	0.40	0.28	0.09	0.20	0.14	−0.02
ZYB	0.28	0.40	**1.00**	0.29	0.41	0.35	0.44	0.29
BBH	0.30	0.28	0.29	**1.00**	0.29	0.25	0.53	0.16
BPL	0.34	0.09	0.41	0.29	**1.00**	0.38	0.62	0.29
NPH	0.34	0.20	0.35	0.25	0.38	**1.00**	0.40	0.10
BNL	0.53	0.14	0.44	0.53	0.62	0.40	**1.00**	0.19
NLB	0.11	−0.02	0.29	0.16	0.29	0.10	0.19	**1.00**

Analysis IV

	GOL	XCB	ZYB	BBH	BPL	NPH	BNL	NLB
GOL	**1.00**	0.40	0.38	0.37	0.29	0.34	0.56	0.06
XCB	0.40	**1.00**	0.38	0.38	0.02	0.20	0.24	−0.05
ZYB	0.38	0.38	**1.00**	0.37	0.38	0.44	0.55	0.26
BBH	0.37	0.38	0.37	**1.00**	0.33	0.26	0.60	0.14
BPL	0.29	0.02	0.38	0.33	**1.00**	0.41	0.56	0.29
NPH	0.34	0.20	0.44	0.26	0.41	**1.00**	0.44	0.09
BNL	0.56	0.24	0.55	0.60	0.56	0.44	**1.00**	0.17
NLB	0.06	−0.05	0.26	0.14	0.29	0.09	0.17	**1.00**

ANNEX 4

Localization of mean differences (P < 0.05) between the two groups under focus and the comparative sample[1]: Scheffe's and Tamhane's tests on regression factor scores.

Analysis I

– factor 1: no differences observed.

– factor 2:

	BAS	BAH	WA	CA	EA	H	NA
BAS							
BAH	•						
WA	•	•					
CA	•	•					
EA			•	•			
H			•				
NA	•	•			•	•	

Analysis II

– factor 1:

	BAS	BAH	WA	CA	EA	SA	NA	K
BAS								
BAH								
WA	•							
CA			•					
EA								
SA	•			•				
NA						•		
K			•			•		

– factor 2:

	BAS	BAH	WA	CA	EA	SA	NA	K
BAS								
BAH								
WA								
CA	•		•					
EA								
SA				•				
NA								
K		•	•	•				

Analysis III

– factor 1:

	BAS	BAH	WA	CA	EA	H	SA	NA	K
BAS									
BAH	•								
WA	•								
CA	•								
EA	•								
H	•								
SA	•		•	•	•	•			
NA	•								
K			•	•	•		•	•	

– factor 2:

	BAS	BAH	WA	CA	EA	H	SA	NA	K
BAS									
BAH									
WA									
CA									
EA									
H	•		•		•				
SA					•	•			
NA	•		•	•	•		•		
K	•		•				•		

Analysis IV

– factor 1:

	BAS	BAH	WA	CA	EA	NA	K
BAS							
BAH	•						
WA	•						
CA	•						
EA	•						
NA	•		•	•	•		
K	•					•	

– factor 2:

	BAS	BAH	WA	CA	EA	NA	K
BAS							
BAH							
WA	•	•					
CA			•				
EA			•				
NA	•		•	•	•		
K	•	•	•	•	•		

1 BAS = Basuku, BAH = Bahutu, WA = Western Africa, CA = Central Africa, EA = Eastern Africa, H = Horn of Eastern Africa, SA = Southern Africa, NA = Northern Africa, and K = Khoisan.